Yuri Dmitriyev

Man and Animals

"LOVE AND RESPECT FOR LIVING CREATURES MUST ALWAYS BE SEEN TO FLOW FROM LOVE AND RESPECT FOR THE HIGHEST QUALITIES AND ASPIRATION OF MANKIND. ALL WHO SEE THE NEED FOR SAVING THE WORLD'S WILDLIFE, WHETHER THEY ARE ANIMAL LOVERS, NATURALISTS, SCIENTISTS, SPORTSMEN OR SIMPLY PEOPLE OF GOOD WILL AND PUBLIC SPIRIT, MUST ENDEAVOUR TO WORK TOGETHER AMICABLY AND TO GOOD PURPOSE. UNITED, WE CAN AND WILL SAVE THE WORLD'S WILDLIFE. DIVIDED, WE COULD LOSE IT FOREVER."

From *The World Wildlife Charter*, 1962

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Man's life on Earth is bound up fast with animals, birds, and fish, insects and beasts, octopi and worms.

But over the millennia Man's relationships with animals have undergone many changes. Animals supplied Man with food and clothes, inspired him with fear and gave him joy, originated customs and beliefs that sometimes influenced the entire mode of life of the given society, they have been enemies, friends and tutors.

God-animals were replaced by worker-animals, wild animals were replaced by domestic ones as the main source of meat. The importance of some animals was enhanced, and of other diminished. And, naturally, throughout Man's history he has brought influence to bear on the animal world — directly or indirectly, consciously or unconsciously.

One book is not really enough to tell about the many different relationships between Man and animals. Nor have I tried to embrace the subject in its entirety. I wrote this book for children, striving, above all, to make them understand how important it is to know, love and protect animals.

Man is strong and wise.

He has therefore to be kind, generous and rational in his relationships with animals.

The Author

Yuri Dmitriyev

Man and Animals

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ЧЕЛОВЕК И ЖИВОТНЫЕ

На английском языке

REQUEST TO READERS

Raduga Publishers would be glad to have your opinion of this book, its translation and design and any suggestions you may have for future publications.

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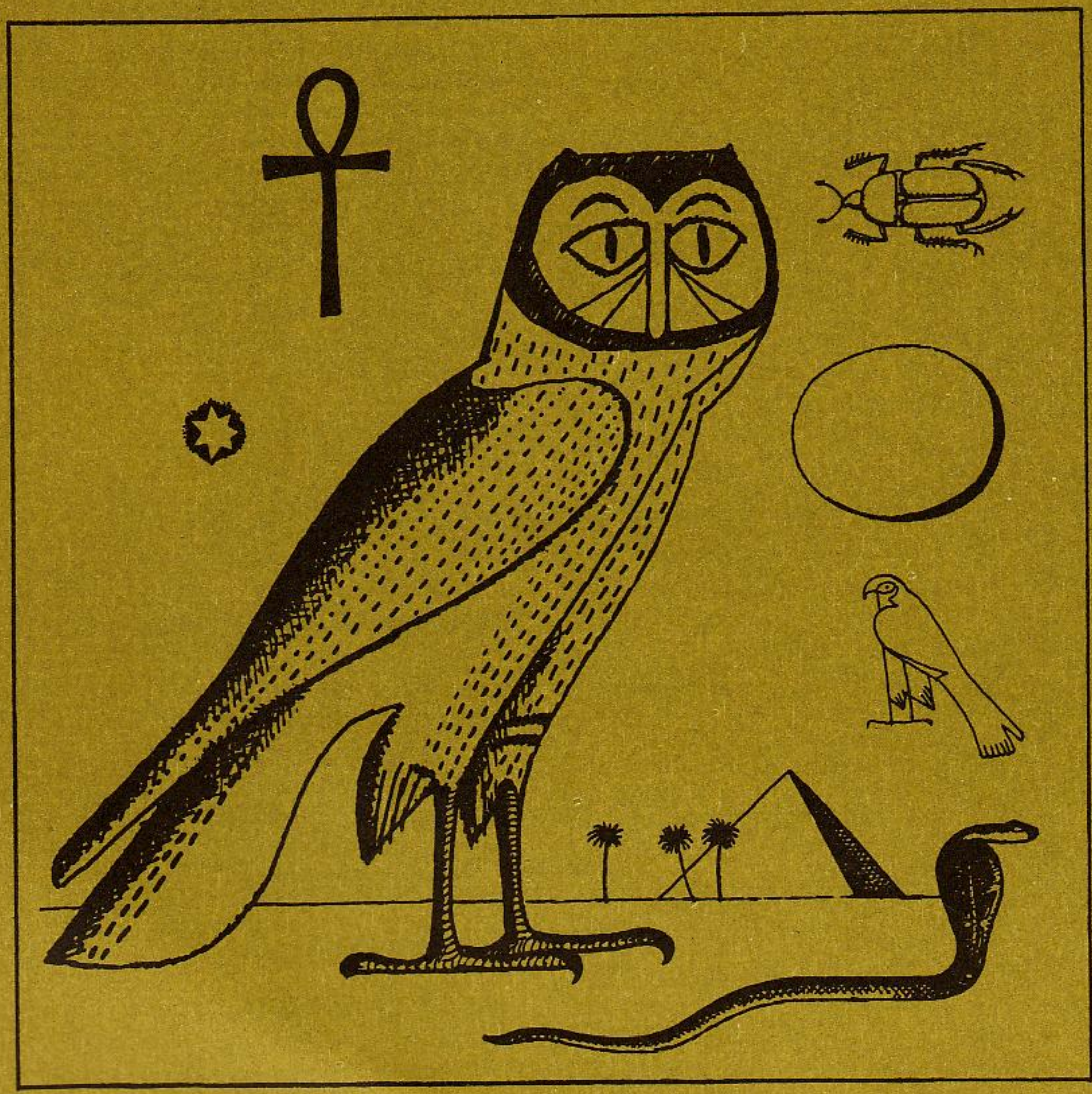
Man Worships and Curses



Scientists know a great deal today about the animals and plants which could be found on our planet in distant past. They gained this knowledge from fossils of prehistoric animals, from prints of plants preserved in deep layers of the earth's crust, from bits of feathers and fur, as well as insects encrusted in resin which turned into golden amber over millennia. While craftsmen use it to make jewelry, scientists find in it information about animal and plant life that existed millions of years ago.

Scientists also know a great deal about our ancestors: the people who inhabited the earth in the distant past. Archaeological and anthropological finds have shown that man's ancestor, who lived some 500 or 600 thousand years ago and was given the scientific designation of Pithecanthropus, was approximately 170 cm. in height and not very bright, since his skull had a volume of only 900 cu. cm.

The type of man who lived on Earth a hundred thousand years later, Sinanthropus, was shorter — only 150-160 cm. in height — but his cranium was much bigger: up to 1,200 cu. cm.

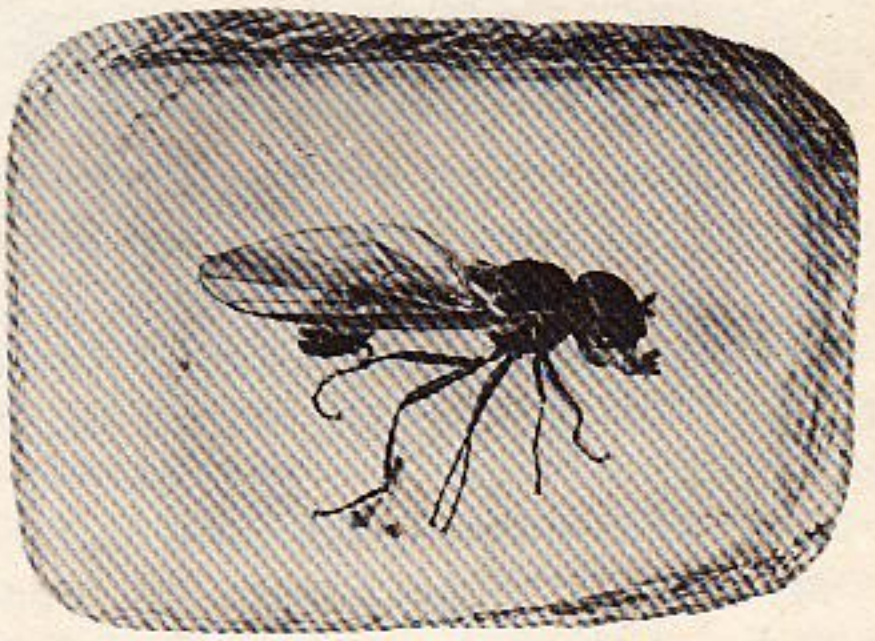
The Neanderthal man who lived some 100-40 thousand years ago was about the same height as the Sinanthropus, but greatly surpassed him as regards mental powers. And, finally, Homo sapiens, the Cro-Magnon man, who appeared 40 or 30 thousand years ago, was, to all intents and purposes, identical to the race of men living today in both height and volume of cranium.

All this information was pieced together by palaeontologists from separate bones or whole skeletons they were lucky enough to unearth. Tools and weapons, stone axes and knives, beads and bracelets told their own tale about the life of our distant ancestors. Since palaeontologists have learned to restore the appearance of a man from the remains of his skeleton, we can even see what Neanderthal or Cro-Magnon men actually looked like.

So far so good. But can we find out about the way primitive men thought? Do we know anything about their customs and rites? It would seem that we don't. After all, they did not leave behind any books, tales or legends. To be sure, we can make some conjectures on the basis of their tools, weapons and household articles — such as what animals they hunted and how. But what did they think while hunting? For a long time scientists believed we would never know this.

And then one day...

Most discoveries are made quite unexpectedly. Especially earth-shaking ones. And the discovery which was made by the Spanish lawyer and amateur archaeologist Sautuola was truly one of the most remarkable discoveries of



Thanks to amber we know what insects lived on Earth millions of years ago.

the nineteenth century. But it brought him no fame and, worse still, lay him open to ridicule. He was even accused of forgery. Contemporary anthropologists mocked him or waxed indignant — what dupes did he take them for, telling them that men who lived many millennia ago were able to draw.

But the drawings Sautuola found were no forgeries. While exploring a cave not far from his home, Sautuola discovered a number of bones, stone tools and other traces of ancient men. The archaeologist made a very thorough study of the cave's floor, knowing that only there could he expect to make any valuable finds. Never once did he so much as glance up at the cave's walls or ceiling.

Then one day, his little daughter came down with him. It took her a long time to persuade her father to bring her along, but once in the cave, she soon became terribly bored — after all there was nothing much to do in that dark, damp place. So from sheer boredom, she began peering around at the walls and ceiling of the cave. And then...

"Daddy, look! Bulls!" she suddenly cried.

"What bulls? Where?" her father asked carelessly, examining yet another bit of bone. "What kind of nonsense are you talking?"

"Look at the ceiling!"

Her father raised his eyes and stood rooted to the spot. Twenty-five almost life-size paintings of animals — goats, wild horses, bulls and bisons — stared down at him from the ceiling of the cave.

News about the remarkable discovery spread all over Spain. In 1880, Sautuola published a book describing it. Thousands of people came to the cave in Altamira Hill to see the prehistoric paintings. Even the king could not contain his curiosity.

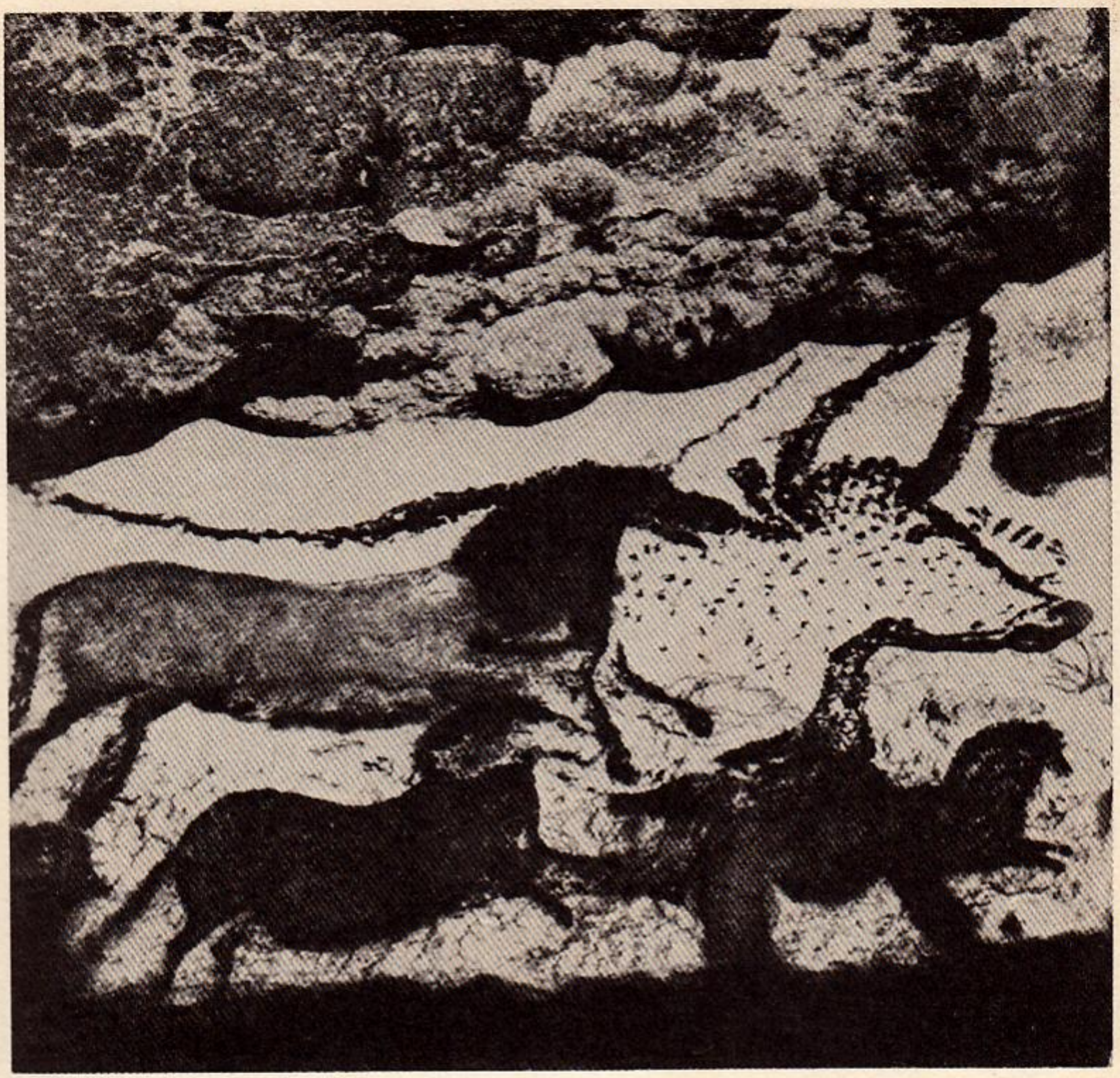
But not so scientists. They did not even deign to look, so sure were they that the paintings in the cave were a forgery, because primitive men could not possibly have been able to draw or, much less, paint in colour.

In vain did Sautuola argue that the drawings were authentic. The learned world refused to believe him, and he died eight years later, in 1888, branded a swindler and a forger. As a matter of fact, in the last years of his life, he was forgotten by everybody, and so were the rock paintings in the cave in Altamira Hill.

Six years after the lawyer's death, one of his learned opponents himself discovered drawings of animals on the walls of another cave. And they depicted not merely bulls and goats but also bears and deer which had been extinct for thousands of years. Both in style and manner the drawings were similar to those reproduced in Sautuola's book!

At long last, the scientists undertook a trip to Altamira Hill. They visited Sautuola's daughter — the very same who had been the first to see representations of remarkable bulls on the ceiling of the cave. And then they were told that quite near Sautuola's cave, local people had since found another underground "picture gallery", but, unwilling to undergo Sautuola's bitter experience, had refrained from making the news public. Sautuola's daughter told the visitors about this find with great reluctance.

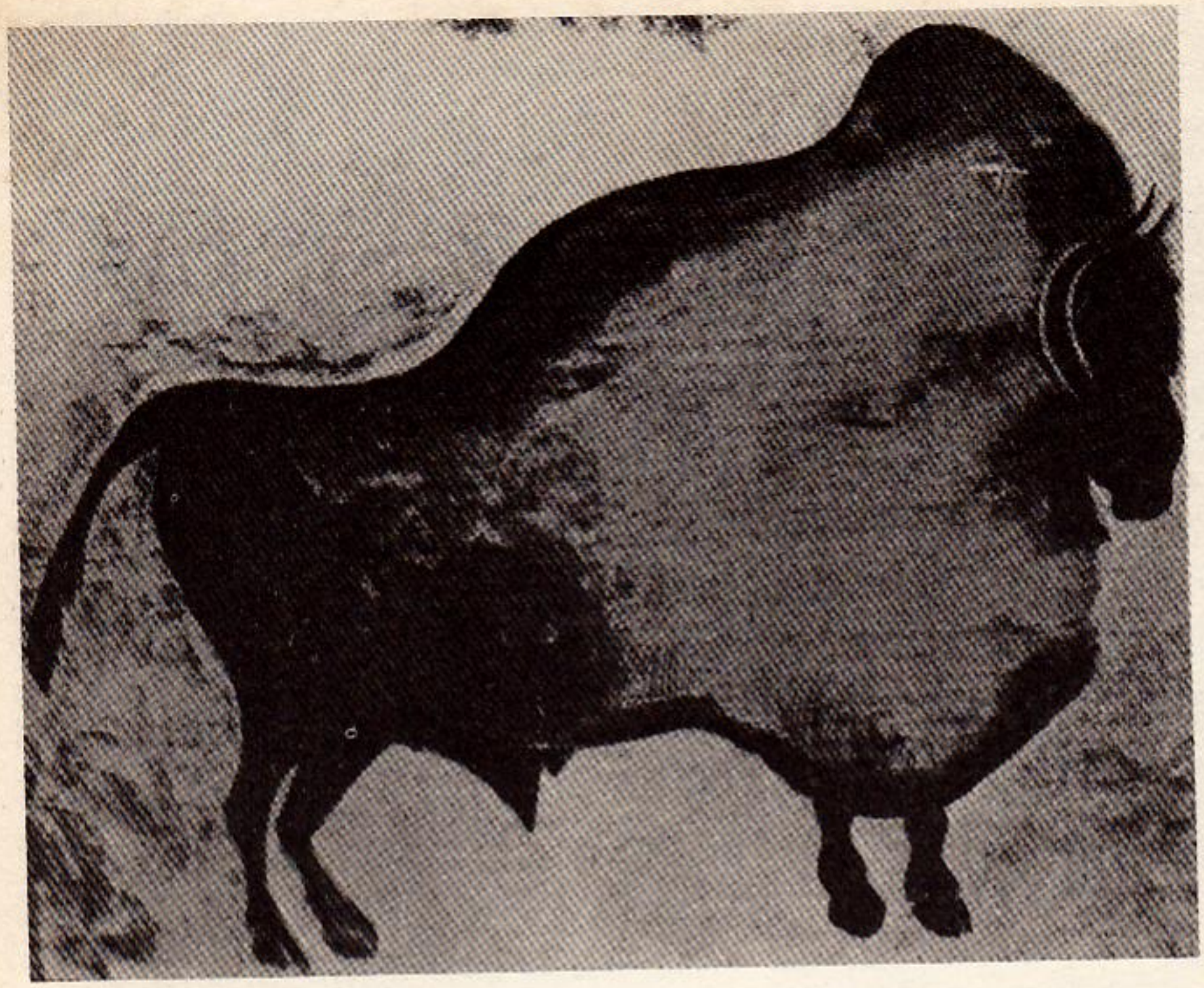
This second cave, nearly 300 sq. m. in area, contained more than 150 drawings of animals on its walls — a real treasure for palaeontologists. Subse-



Bulls painted by a primitive artist millennia ago.

quently several more caves with rock paintings were discovered. The entire scientific world was rocked, so to speak.

For now they had not merely bits of fur or bone to tell them about the animals of distant past but eyewitness accounts. Here were portraits of these animals made from nature. Some were done in colour, while others were just scratched or hewed on rock. There were whole herds of bisons, deer, horses and mammoths! It has since been established that prehistoric artists used ferric oxide and manganese peroxide which they pounded and mixed with fat to obtain a variety of hues — from yellow to red, in the case of ferric oxide, and from brown to black in the case



Another "portrait" of a bull left us by a Stone Age artist.

of manganese peroxide.

Soon it transpired that there were sculptors as well as painters among prehistoric artists, for figurines of animals modelled from clay were found in caves.

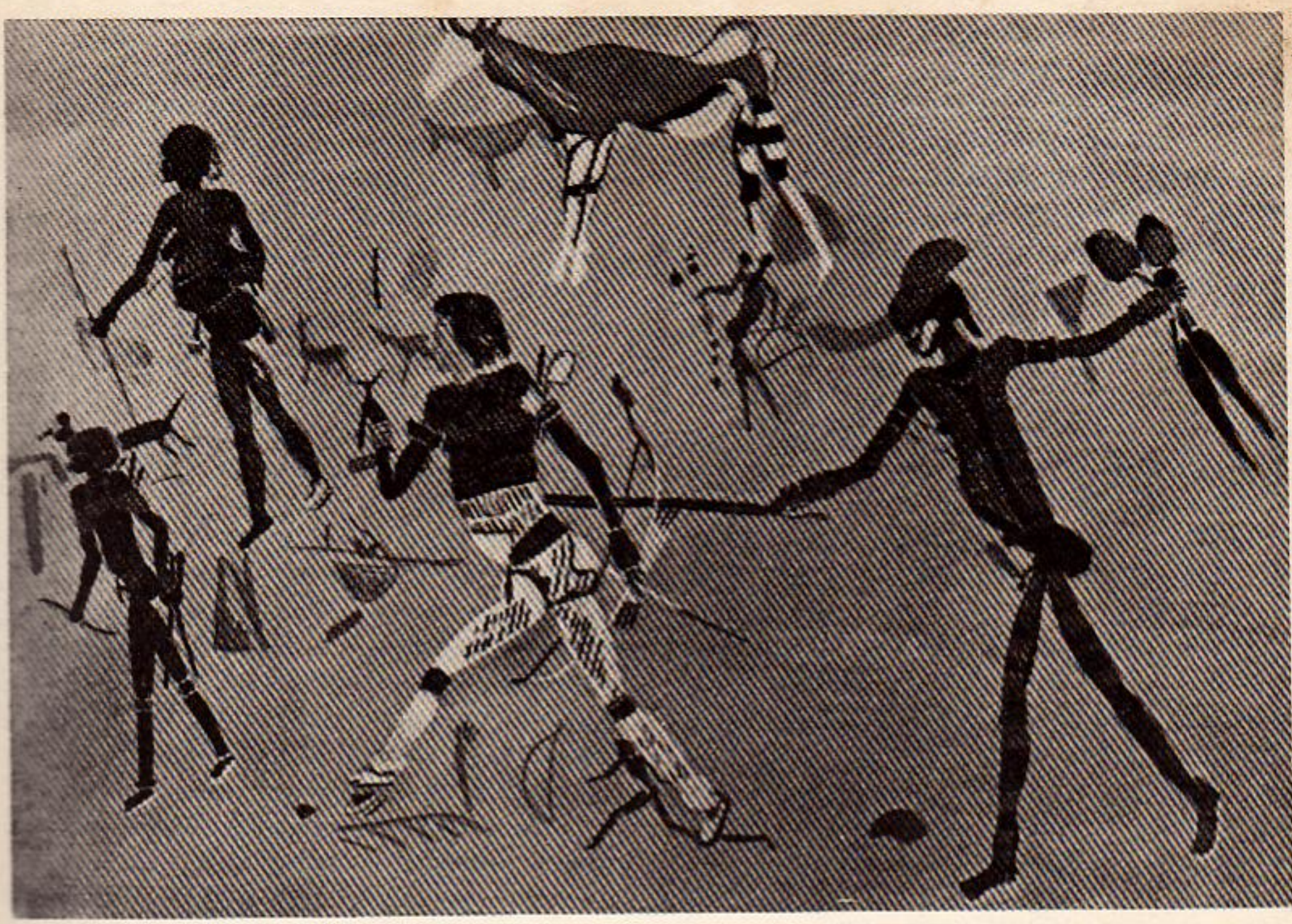
The very fact that primitive men could draw and model was in itself an epoch-making discovery.

But as more and more rock paintings were found and studied, curious aspects came to the fore.

It was noticed, for instance, that most of the animals in rock paintings were presented as either wounded or dead, or, at the very least, with an axe or a large stone drawn on top. What could be the meaning of this?

Dancing Is a Serious Business

Two men of strange appearance — with long sharp horns tied to their heads and tails dragging behind — ran out into a clearing. They stood still, listening alertly and glancing round, then started jumping in imitation of antelopes. Suddenly there was movement in the bushes at the edge of the clearing. The antelope-men dashed towards the thicket. But a line of hunters with spears at the ready blocked their path. The "antelopes" dashed back, but more and more hunters emerged into the clearing. With little hops, pausing and whirling around, they advanced on the "antelopes". And their primitive but



The primitive artist was undoubtedly a hunter. In this scene he possibly portrayed himself as well.

fearsome weapon swung in time. The "antelopes" dashed hither and thither in despair as the hunters closed in on them. The two men were really as slim, light-footed and agile as antelopes. One of the "antelopes", his head lowered, attacked the hunters in the hope of breaking through the deadly ring. But he met a row of bristling spears and had to retreat. The ring of dancing hunters tightened. Again and again the "antelopes" attacked them in a dash for freedom. Then one hunter tossed a spear (for this purpose they had special spears with dull tips). The "antelopes" dodged it. A second spear and a third missed the mark again. The "antelopes" continued their desperate lunges. Suddenly a hunter missed his footing after throwing the spear. He jumped up with lightning speed, but it was too late — the "antelopes" broke through the ring and disappeared into the forest. The dance ended at once and angry faces were turned on the culprit. He covered his face with his hands and stood there, the picture of dejection, knowing that a severe punishment was in store for him, perhaps even death — the decision would be made by the elders. And he knew he deserved it too, for his mistake meant that the tribe would be left without meat, possibly for a long time. His fall might very well have doomed the tribe to death from starvation.

This or something like this was what the unlucky hunter believed, and the rest of the hunters as well. What had been enacted in the clearing was not merely a dance but a rite of supreme importance. It wasn't a rehearsal or a training session for a hunt — it was, to their minds, a real hunt, perhaps even the "main" hunt.

Two men from the tribe — the fastest and most agile — tied on horns and tails and represented antelopes, while the others hunted them. If a spear "felled an antelope", then the hunt the next day augured to be successful. If the hunters failed, then the hunt was postponed, for it was doomed to failure.

So reasoned Bushmen of South Africa. So also believed Mandan Indians of North America, who put on masks representing bisons, tied on their tails and executed a dance in which they sought to imitate the movements of these animals. These "bisons" were tracked down by hunters. After "killing" one with blunt-tipped arrows, they "cut it up" and then went after another. This hunting rite went on for several days, sometimes even weeks running, not even interrupted at night, and only afterwards did the hunters go after real bisons.

Even today, before setting out to hunt jaguars, Brazilian Indians of the Bororo tribe spend the night singing songs about what a wonderful beast a jaguar is and how useful it is to people. In the morning they gather round a representation of a jaguar drawn on the ground and begin to dance. Then spears are thrown at the picture of the jaguar, and only when somebody hits the eye of the animal drawn on the ground, do the Indians start on the actual hunt. Now they are assured of success; they believe that what happened to the animal drawn on the ground is sure to be repeated in actual life.

A custom similar to this is still practised by Australian aborigines. Only instead of a jaguar they "kill" a representation of a kangaroo traced on the ground.

By observing the rites of Australian aborigines and comparing their drawings with the rock paintings, the scientists gained an insight into the mentality of primitive men: they, too, "killed" their painted images before starting on a hunt.

This was a discovery of no lesser importance than the actual discovery of rock paintings. Now scientists knew that primitive men not only killed animals but also worshipped them.

Prehistoric hunters were strong, patient, agile and skilful, but their hunts were not always successful.

The Pithecanthropi and Sinanthropi were unable to discover the logical reasons for success or failure and they probably never tried to, because their minds were not up to the effort. Not so the Neanderthal and Cro-Magnon men. They began to seek ways of making life easier.

One way was to improve weapons and methods of hunting. But there seemed to be yet another way, prompted to the primitive men by nature itself, so full of the most inexplicable miracles and puzzles.

Most puzzling of all, of course, were the animals, so strong and cunning.

Could they be outwitted? Primitive men saw no fundamental difference between actual animals and their representations. They believed that if they drew an animal and then "killed" the picture, the hunt proper would be nothing but a formality: after all the animal had already, to all intents and pur-

poses, been killed. The fact that it was still capable of running away, hiding, or resisting was a mere trifle.

Gradually this "preliminary hunt" acquired more and more complex attributes, with special songs and dances devised for the purpose, but the essence remained the same — it was a precondition for a successful hunt. We do not know, of course, how the rites were referred to by prehistoric men, but today they are called hunting magic.

Different peoples had different beliefs. The people of Madagascar, for instance, were strictly forbidden to kill a creature of male sex inside a house, be it a tom-cat, a rooster or a male rat. It was believed that such a killing might cause the death of a warrior. Incidentally, warriors on Madagascar never ate the meat of hedgehogs, which were considered cowardly animals. It was believed, and not only on Madagascar, that after eating the meat of a cowardly animal one would become cowardly himself. And on the contrary, eating the meat of a strong and brave animal made one strong and brave.

People also believed that there were other ways, through dance, song and incantation, to acquire the useful properties of animals. For instance, by hiding a peace of rat skin in the hair and pronouncing a corresponding incantation or dancing an appropriate dance, one could acquire the rat's nimbleness.

There were also numerous magical rites for healing connected with animals. It was believed, for example, that an owl preserved one from insanity. Even mad dogs presented no danger to one who carried in his armpit an amulet containing an owl's heart and right foot. (This superstition persisted in Germany till the 19th century!)

There was also a magical cure which consisted of "driving" the illness out of man and into an animal — several hairs of the sick man were mixed into the feed of a pig or a dog in hopes that the illness would be transmitted to the animal and the man would be cured.

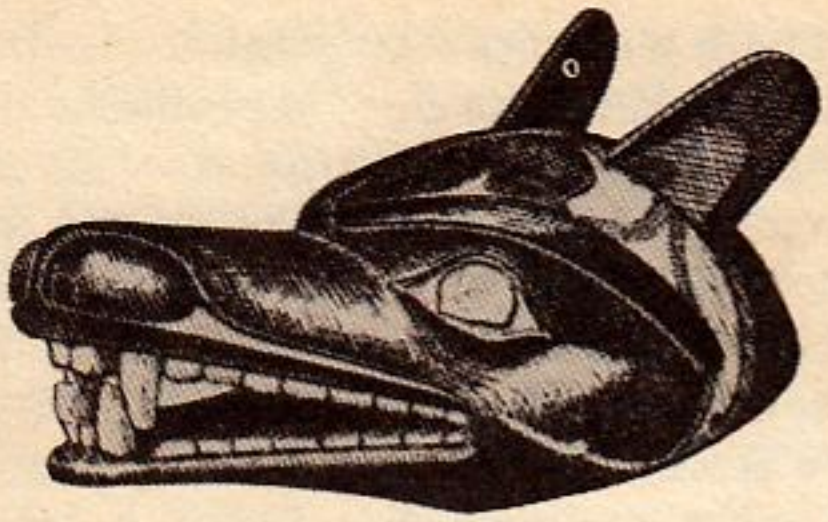
A great variety of other magical rites were evolved, but hunting magic remained the most important. Of course it was constantly undergoing changes and assumed different forms with different people. The Eskimos, for instance, still have an annual "bladder festival", when they lower inflated bladders into the ice-holes made by seals in the hope that this will help increase the seal population so the people will have plenty of meat and fat.

There are a great number of rites practised by hunters, some amazingly similar although they emerged on different continents, others dissimilar although practised by close neighbours. But all have one purpose — to assure a successful hunt.

There was, however, a curious phenomenon to be observed: the hunt had been successful, the animal was lying dead on the ground, yet the hunter seemed in no hurry to start skinning it and cutting it up. Was this more magic?

"Don't Be Angry That I Killed You!"

The hunter walked over to the bear lying prostrate on the ground and sat down beside it. The difficult and dangerous hunt was over, and, what was more, the strenuous preparations for it had ended. Before starting on a bear hunt, the Indians fasted for many days, and on the eve of the hunt, they offered sacrifices to the animals they had



The "coat-of-arms" of a North American Indian tribe. As distinct from Europeans, Red Indians had a very high opinion of the wolf, respecting his courage, strength and independence. The tribe which traced its origins to the wolf was very proud of its ancestor and the tribesmen took great pains in fashioning their totem sign.

killed before. Now the tribe had a large stock of meat, and it seems the hunter should have hurried back to where he was impatiently awaited by women, children and old folk. But the hunter took his time. Squatting beside the carcass, he lit up a pipe and put it between the bear's teeth. He waited a long time for the bear to "smoke" the pipe to the end and then explained to him at considerable length why he had had to kill him, asking his forgiveness at still greater length, pleading with him, and imploring him not to bear the tribe a grudge and not to spoil their hunts in the future.

Nor did the ceremony end here.

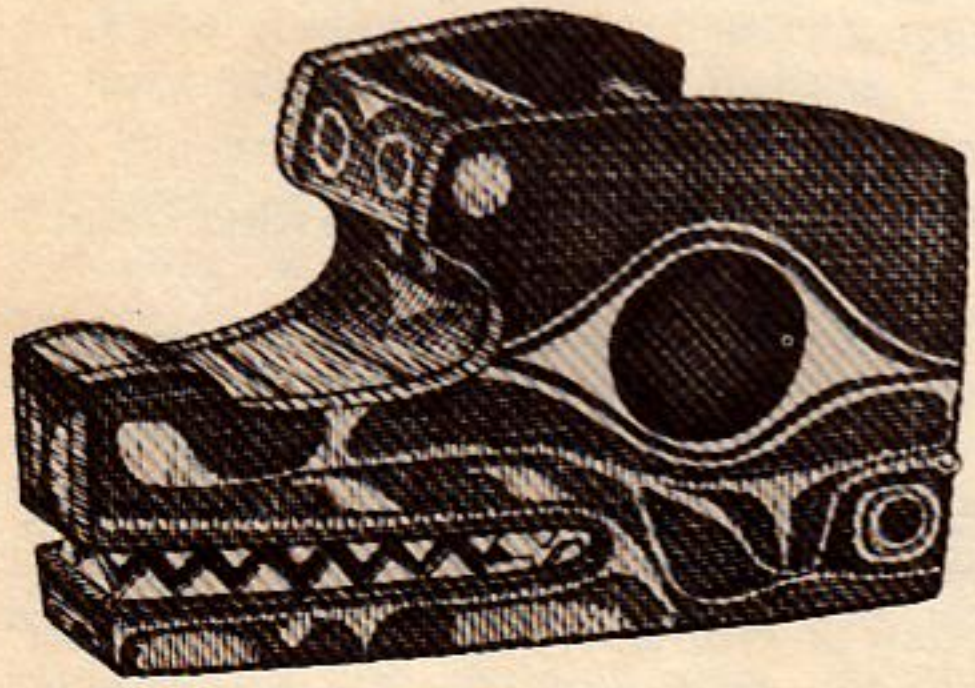
After the bear's meat had been eaten, the Indians put the bear's head, painted various colours, on a tall pole and spent a long time talking to it, praising it lavishly.

Thus acted Bear tribes. There were also Wolf, Raven, Fox and Serpent tribes. These were no mere nicknames, for the Indians believed that all people were descended from animals — some from wolves, others from bears, and still others from ravens or foxes. Such beliefs are called totemism, from the word "totem" which, in the language of the Ojibwa Indians means "his clan". In other words, this meant that a particular clan was descended from a bear, or that its ancestor was a bear (or raven, fox, or wolf respectively).

It is hard to say when this belief in animal-ancestors first originated. At any rate it could not have been later — and perhaps it was much earlier — than the time when primitive artists painted animals on the rock walls of their caves.

Ancient people believed that they were descended from animals. Each tribe had his own ancestor which it was supposed to revere, which it was not allowed to kill, and which it was expected to protect. It is one thing to protect ravens or snakes which were not hunted much anyway, but what were they to do about bears, whose meat was much to the taste also of those tribes which traced their origins to this animal?

Bears' skulls have been found in large numbers in excavations of caves and other dwellings of primitive people.



The "coat-of-arms" of a Canadian Indian tribe "descended from the wolf".

Skulls, mind you. Obviously primitive hunters paid some kind of homage to the bears they killed. Perhaps they asked their forgiveness, as the North American Indians do. Perhaps, they held some kind of solemn ceremony around a dead bear, then carried the carcass to the village and, after eating the meat, gave the bones a reverent burial, as was done by the Evenki, who considered the bear their "grandfather". Or perhaps, like the Mansi, once the bear's meat was eaten, they put its skull in a place of honour in their homes.

Be that as it may, there can be no doubt that primitive people considered animals to be their "ancestors" and worshipped them. And if they killed an "ancestor" (and they had no choice but to kill, for they needed food) they did all they could think of to placate the spirit of the animal they had killed.

Echoes of those ancient beliefs have come down to our own days. We know for instance that Australian aborigines count among their ancestors Milbili the lizard, Mindi the snake, Volunk the boa constrictor and Kipar the turkey-cock.

We also know that many tribes which lived in present-day Europe, like the American Indians, considered bears to be their ancestors. Some tribes living in the Congo believe themselves descended from elephants. They have to hunt these animals, but they always assure them that the killing was an accident. As proof of this, they stage a spectacle in which the tribesmen "attack" the killers of the elephant and "punish" them cruelly for the murder.

Some tribes in Australia trace their origins to bats, and on Madagascar some believe themselves related to crocodiles. As a matter of fact, it would be hard to name an animal which has not been regarded as the ancestor of some primitive tribe.

Birds or Animals?

Our distant ancestors firmly believed that men were descended from animals. To begin with, they were quite content to have it so. Yet, as man's intellectual powers developed, he began to ask himself where the animals had come from. Who created all things that were? And naturally, he arrived at the conclusion that the world began with an animal. But which one?

An endless expanse of water, darkness and silence — this is how the tribes living on the territory of present-day Egypt pictured the primeval world. Then a hill arose amidst all that water. On it sat a frog, and beside it lay an egg. This was the beginning of all things.

This bone figurine of a caribou was carved by an Eskimo sculptor from Greenland.

Among Ancient Egypt's many sacred animals there were also birds of prey. A representation of one such bird has reached us.

A goose, a bird endowed with a loud voice, was hatched from the egg. He began to gaggle, and silence was no more. Darkness was dispelled as well, for the goose, like the sun, emitted light. Then the goose set about creating all the creatures that populate the world — animals and men.

So the world was created by a bird? Yes, many other ancient myths propose similar explanations. Ancient Egyptians believed that the Sun God Ra, who begot both heaven and earth, emerged from an egg in the shape of a bird.

The Australians had a myth about two bird-brothers who waged a fierce war between themselves. One of them created land, people, trees and animals and the other, water and all its inhabitants.

The Melanesians also ascribed the creation of the world to two bird-brothers. One brother was wise and kind,

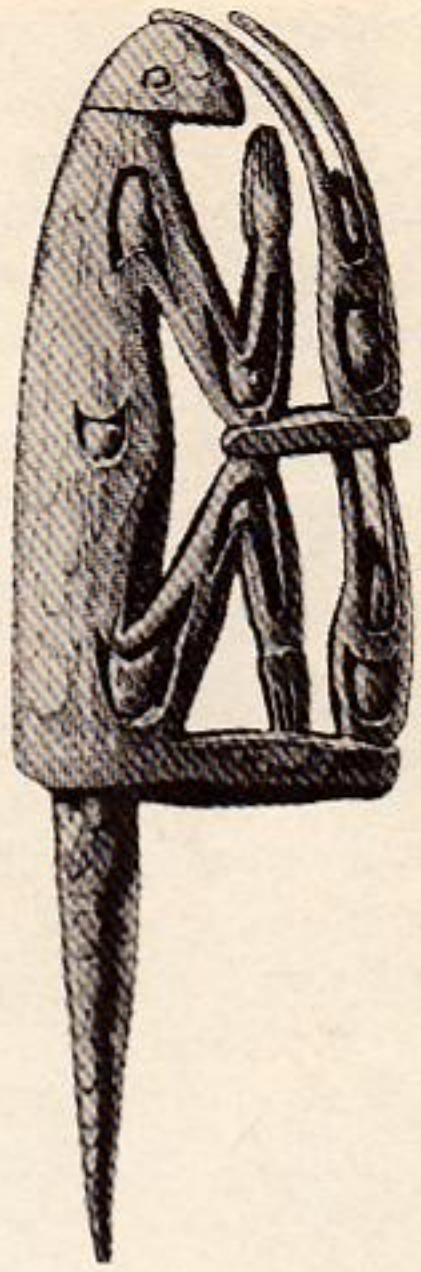
And this is not a magic dance but a real hunt.

and he created fertile earth; the other, who was stupid and mean, did his best to spoil it.

Many peoples living at great distances from each other believed that birds were the creators of all things. Some tribes meant birds generically, while others, like the Polynesians, had a special mythical bird Taaroa who laid an egg from which the world emerged.

Some peoples regarded the raven or the eagle as the world's creator. Of course these designations on names for birds appeared much later; for the primitive people must have had their own names for them, or they were just birds of a definite size, colour and appearance. Here is the legend about the creation of the world born many centuries ago in the north of Russia:

At first there was only water and two birds, a black and a white one.



The praying mantis, a totem from New Guinea

"The Magic Owl", the work of a modern Eskimo artist from Canada.

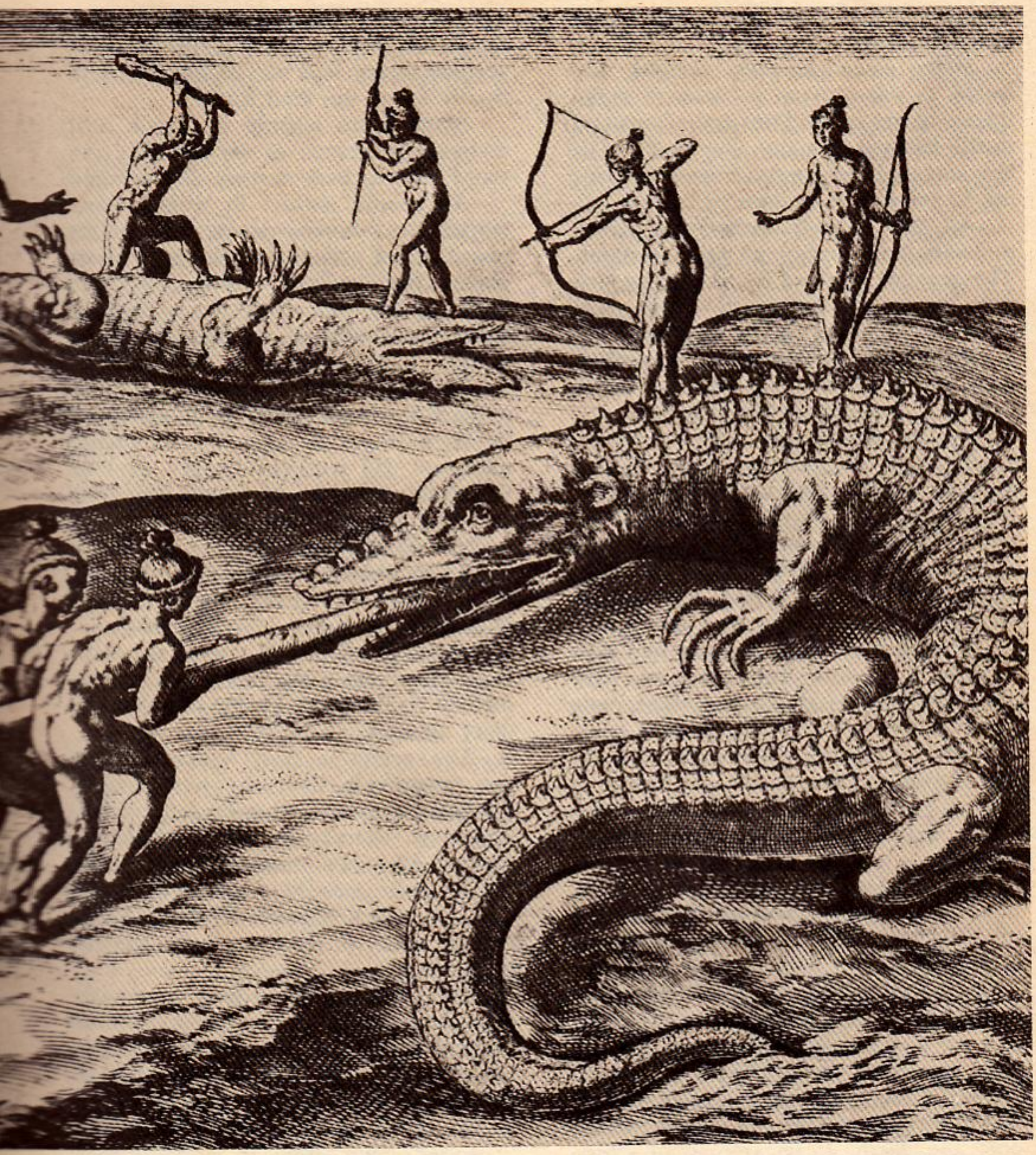
The white bird flew above the water, and the black one swam in it. The white bird asked the black one to dive and bring up some silt. The black bird did so, but left some silt for itself. And when, through the white bird's magic, the silt began to grow into Earth, the little bit the black bird left in its beak also swelled and began to choke it. The white bird cried out to the other to spit the silt out. The black bird spit it out, but it was too late, and this bit of silt could not make good land; it grew into rocks and mountains instead. And this was the cause of a quarrel between the birds. So white birds came to be regarded as good, and black as evil, the harbingers of calamity, seeing that the white bird created all things that are good and useful for man, and the black one was responsible for all bad things on earth.

There are quite a few legends, however, where animals and not birds were instrumental in the world's creation.

Here is an Australian version. Once there lived the Great Kangaroo. He was attacked by vicious dogs and saw that there was no escaping them and that they were going to tear him to pieces. So he decided that his pieces would go to create the world. Where his liver fell a hill rose, his skin became rocks, and his bones made stones, and from these stones appeared men.

The Evenki have their own legend of the world's creation, according to which the world was created by a mammoth and Dyabdyar, a mythical serpent.

A small island lay in the middle of a great expanse of water. It was so tiny nobody could possibly live on it. So, in order to enlarge it, the mammoth began to dig to the bottom of the ocean with his tusks and trunk and bring the soil up. Meanwhile the serpent crawled



This picture by a 16th-century "eyewitness" shows the hunting of crocodiles in Florida (from a book printed in 1591).

over the island, levelling the soil and building the island up.

Well, since animals created the world, it was also up to them to make it good to live in. And this actually occurs in the legends of many peoples. Here is how day and night were created according to the Creek Indians.

All the animals gathered together to decide the question of day and night. The meeting chaired by the bear Nokozi was very turbulent. There was a lot of argument. Some animals, who preferred life in the dark, wanted it to be night all the time, others, on the contrary, demanded unending day.

Finally the dispute was solved by a chipmunk named Chu-tlok-chu. He pointed to the raccoon Vytko, or rather to his tail, and all saw the black and white stripes alternating in the raccoon's beautiful fluffy tail. The chipmunk said that day and night must alternate like the rings on Vytko's tail.

The animals were amazed at Chu-tlok-chu's wisdom and resolved that day should follow night, and night, day, at equal intervals. But Nokozi the bear was envious of the chipmunk's wisdom and scratched him on the back in irritation. Ever since then Chu-tlok-chu's descendants have had striped backs.

The Algonquian Indians have an interesting legend about another aspect of the earth's creation, also a very important one.

It appears that in the beginning, the entire earth was covered with snow, and the waters had a thick crust of ice. Life was very hard. Then a weasel chewed a hole in the vault of heaven, and warm winds and sunrays poured down onto the earth. It became warm, and the snow and ice melted. The weasel opened all the cages and let the birds out. It performed many other kind deeds, but the dwellers of the heavens became angry with it, set upon it, and finally killed the kind weasel.

Many more legends in which animals are presented as the earth's creators have reached us from distant ages.

As people gained in wisdom and learned to control nature, new myths appeared in which man the conqueror played the leading role. Such is the myth of the Maoris of New Zealand about Tu-Matauengi, the father of fierce men.

One day there was such a terrible storm that animals and fish scattered in fright, leaving their uncle Tu-Matauengi all alone. He was very angry, and in punishment, began to catch fish with nets and animals with traps and taught men to do likewise.

As mankind matured and accumulated experience over centuries and millennia, people domesticated animals and developed the sciences. Still, their ideas about the animal world remained fantastic. Now they began to deify animals.

The primitive man hunted in order to provide food for himself and his tribesmen, and what he bagged belonged to everybody. With the development of animal husbandry and land tilling, some people grew rich, while others remained poor. Thus exploitation of man by man and class society were born.

The primitive man drew an image of a deer killed by an arrow, danced a ritual dance and pronounced incantations in order to win the good will of evil spirits and assure the assistance of kindly spirits in his hunt.

Later, man began to worship gods instead of spirits. These gods often had the form of an animal. The correspond-

ing animals were deified and paid homage to. If they were ever killed, conditions were specified for the procedure.

The Divine Apis, the Sacred Scarab and the "Keeper of the Horizon"

Primitive men, as was only natural, worshipped wild animals. People who lived in ancient states deified animals which had practical importance, primarily domestic animals. Among wild animals, they worshipped those which were useful or at any rate were believed to be useful. This is one of the reasons certain animals came to be worshipped. But as time passed, the original reason was forgotten and the worship of animals became religion. Animals became gods. And among these divine animals, the place of honour belonged to the cow and the bull.

"Cows are our strength, cows are our need, cows are our food, cows are our clothes, and cows are our victory," said a Persian holy book.

Cows were deified by ancient Persians, Hindus, Cretans, some African tribes, and ancient Greeks. Still "the cow cult" was most developed in Egypt. Egyptian priests asserted that the soul of the chief Egyptian god, Osiris, was embodied in the bull, while the soul of his sister Isis lived in the cow. No wonder the bull held pride of place among Egypt's sacred animals. The sacred bull had many names. Each of the towns which worshipped the bull (and there were many towns in Egypt which had an animal-god of their own) gave it a special name. But the best known of these are Mnevis and Apis.

A bull had to conform to a number of requirements (nearly 30) to be held sacred. For example, it had to have a spot on its right flank in the shape of the moon, and under the tongue it had to have a knot which the Egyptians called "the beetle". Its coat had to be black and rough, on its forehead there had to be a square of white, and on its back a spot resembling an eagle, while the tip of its tail had to be forked.

Once a bull meeting all these specifications was found, it was led to the temple with honours and became an object of worship. The bull spent twenty-five years in the temple and was adorned with gold, silver and precious stones. It was taken for walks in a park laid out for this express purpose; it was fed choice grain and washed in scented baths. After twenty-five years he was sacrificed — drowned in a pool, because the soul of Osiris could no longer remain in an old body.

After drowning the bull, the priests shaved their heads, put on mourning and set out to look for another "receptacle of the god's soul." But the carcass was not thrown away — after all Osiris's soul was supposed to have spent twenty-five years in it!

In 1851 French archaeologists discovered in the vicinity of Cairo a huge underground tomb which contained numerous mummies of sacred bulls laid in sarcophagi of red and black polished granite. This tomb was used as the burial place of sacred bulls for 1,500 years.

Cows, rams, sheep, goats and cats had their own priests and their own temples in Ancient Egypt. The cult of the dog was also widespread.

On the eve of the annual flooding of the Nile, a bright star usually appears in the sky. It gives a warning, as it were, of the impending flood. Unable to account for the appearance of the star in a rational way, the Egyptians saw it as a

manifestation of the supernatural. They associated it in their minds with a dog that barks to warn of the approach of a stranger. So the star was named Sirius (a hound), and the dog itself became a sacred embodiment of watchfulness. Its representations appeared above the doorways in the temple of Osiris and Isis, and subsequently on other temples as well.

The Egyptians also worshipped birds, especially the ibis. It was reputed to eat large numbers of insects, which infested the fields of Egyptian peasants and was even supposed to kill snakes, so numerous in Egypt.

The kite was worshipped for his useful function of sanitation.

Probably for that same reason — because he ate carrion — the jackal was also considered a sacred animal. He even had the title of the "Keeper of the Horizon". There were, however, some animals, which did not deserve the protection given them.

Great homage was paid to baboons, although their herds destroyed a large share of the harvest. Perhaps this can be accounted for by their resemblance to dogs or by their reputation for protecting a locality from predatory animals. It was believed that lions, leopards and the like avoided baboon territories. The Egyptians also believed baboons could find fresh water anywhere, and this was a crucial matter for the Egyptians.

Many more animals, birds and fishes were regarded as sacred in Ancient Egypt, but one of them, the sacred dung-beetle, scarabaeus, scarab for short, deserves special mention.

The Egyptians noticed an interesting detail in the behaviour of this beetle. At a certain season, it is seen rolling a ball of dung along and then burying it in some hole. This is hard work, considering that the dung ball is often much bigger than the beetle itself.

But industriousness was not the only feature to attract the Egyptians to this beetle, though this did play a considerable role in its being chosen as a sacred animal. Priests also noticed that beetles did not give birth to their young in the way cows or sheep do. Their young appeared from unattractive-looking lumps of dung. Of course, had it occurred to the priests to examine and watch these lumps, they would have discovered that beetles laid their eggs in the dung balls, that larvae were hatched from these eggs after some time, and that finally these larvae underwent a transformation and became beetles. But in those distant times nobody bothered to study the life of insects, and the appearance of beetles from lumps of dung seemed to be a miracle which could only be wrought by a divine animal. All the more so since the priests had counted thirty segments on each leg of the dung-beetle, which corresponded to the number of days in a month, while the dung balls were an embodiment of the Sun God Ra. The priests maintained that there were no females among the scarabs.

Still and all, the chief manifestation of godliness was the appearance of young beetles from lumps of dung. The priests asserted that the beetles collected refuse and then, from these "earthly ashes", created a new beetle.

Very soon the dung-beetle became one of the most important sacred animals in Egypt. Beetles were mummified and placed together with human mummies. Their representations are found on temple walls and on monu-

ments. Gradually, however, live beetles came to be replaced with artificial ones, made of gold and precious stones on which were carved the names of pharaohs and words of prayers.

Among Egypt's more than one hundred sacred animals, a place of honour also belonged to the crocodile.

Every year, the Egyptians impatiently waited for the Nile to flood, since the crop depended on the amount of silt left in the fields after the waters receded. But along with the floods, a great number of crocodiles were brought into the Nile valley from the upper reaches of the river. The Egyptians decided that it was not the water which brought the crocodiles, but the crocodiles which brought the life-giving water. And since water was of paramount importance, the crocodiles came to be worshipped as extremely useful and, consequently, sacred animals.

Sacred crocodiles were placed in marble pools in shady parks surrounding temples. They wore gold rings and bracelets on their legs, precious stones adorned their heads, and their food was brought to them on silver dishes. Once a year, the Nile Festival was held in Cairo, and a beautiful maiden was sacrificed to the crocodiles.

Thus lived the crocodiles, in respect and prosperity, never suspecting that their rise marked the beginning of the downfall of another sacred animal, the mongoose.

Mongooses had been revered for destroying snakes which plagued the Egyptians. The legend had it that crocodile eggs were a favourite dish of the mongoose. And the Egyptians were not prepared to stand for this. As crocodiles gained greater eminence, things became harder for mongooses, who were killed on sight. Still, there

The head of a sacred bull found during excavations on Cyprus.

remained localities where the crocodile was not held in much esteem, and there, the mongoose remained much beloved and respected.

Sacred Cows and the "Owner of the White Elephant"

However numerous Egypt's sacred animals, the Hindus had many more of them. The Hindus believed in transmigration of souls. According to them, the human body was but a shell for the immortal soul. After a man's death, his soul left the now useless body and

migrated into another one, perhaps that of an animal.

A dog running in the street, for instance, could be merely a dog. On the other hand, it could be the abode of someone's soul. Whose soul, it was impossible to tell. Nor could you tell where the soul of a respected person recently deceased had found a new home. It could inhabit any of the numerous animals around. If you kicked a goat or killed a bird, you might, all unknowingly, kick or kill the carrier of a soul whose human shell you did not so much as dare to touch!

This was really hard on the Hindus. Even Brahma, the creator of the universe, was reputed to have been reincarnated into animals, a raven and a sparrow. And Vishnu, another prominent deity, was reincarnated into a fish, a turtle, a boar, and a domestic pig. If that did not make these animals immune, what did?

But even if the animal in question was not a deity, and if no human soul had transmigrated into it (and how could one be sure of that?) it was still risky to meddle with an animal, since the gods used many of them to ride about on. And those which were not used for riding performed various other services for the gods. For instance, monkeys helped Vishnu defeat a huge and terrible giant. The god concluded a treaty with the Monkey King, and the latter sent numerous detachments of monkeys and bears to his aid.

Other animals had other services to their credit. The elephants (seven of them), for instance, supported the Earth on their backs, themselves standing on the back of a great turtle.

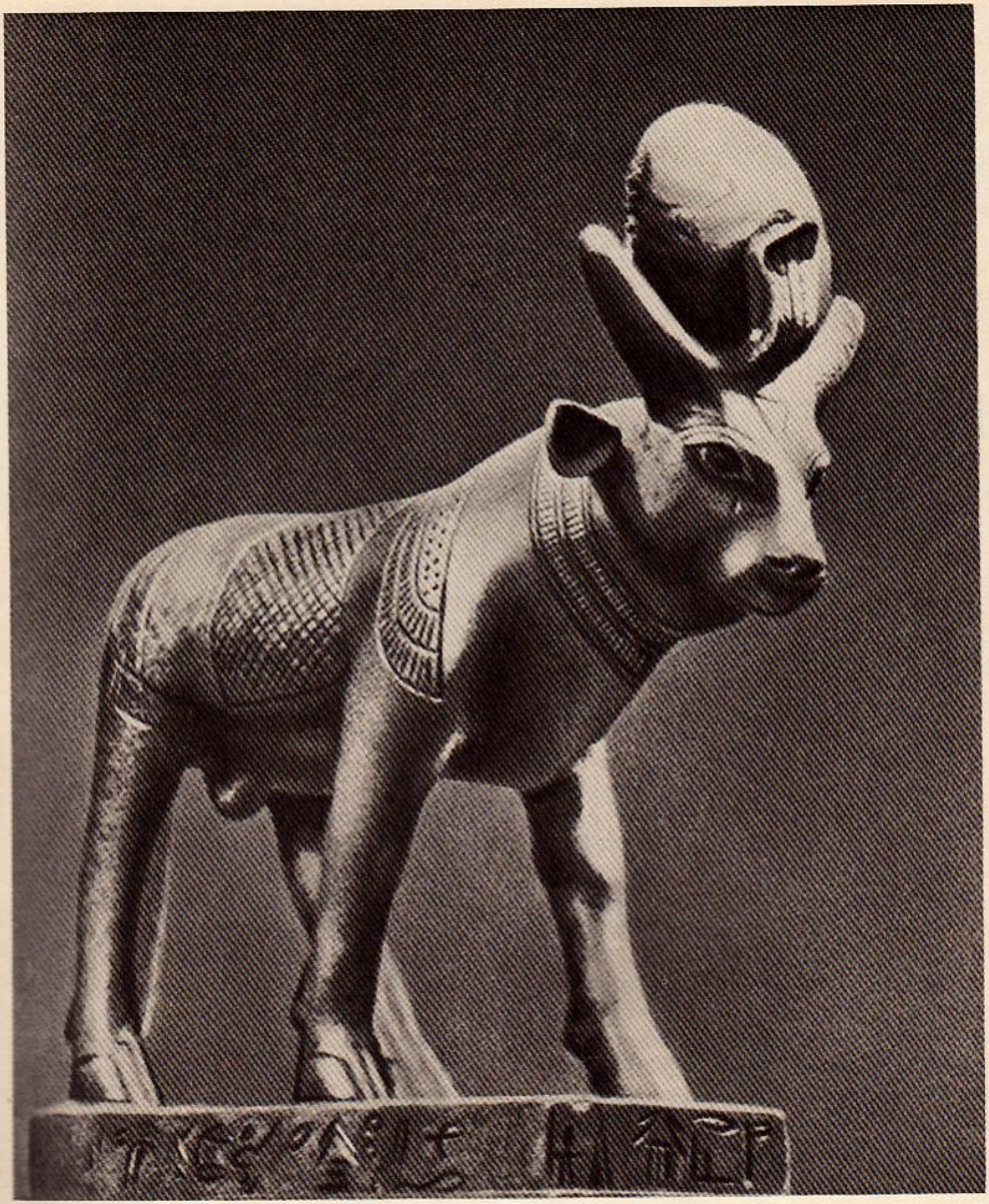
And, finally, even if an animal was neither a god nor the home of somebody's immortal soul, even if it had taken part in no battles and did not support the Earth on its back, it still was a symbol. The lion was the symbol of strength; the dog, the symbol of watchfulness; the rooster and the peacock, besides watchfulness, also embodied pride; the white bull embodied justice and virtue. There were also symbols of evil — the tiger, the raven, and the snake. And symbols could not be meddled with either!

In other words, the list of sacred animals, commanding respect and immunity embraced nearly the whole of the animal kingdom. A true believer did not dare to strike, to say nothing of killing, an animal. He had no right to squash a worm or swat a fly, and was of necessity a vegetarian. Not so long ago you could see people in India who wore a gauze mask for fear of swallowing a mite.

Still, people always managed to get round the laws. Only a very few animals were really immune: primarily, the cow, the white elephant and the monkey.

The cow, the symbol of goodness and a true friend of Vishnu, was held in inordinate esteem. The wildest imagination would be unable to think up greater honours than those bestowed on the cow by the Indian priests, the Brahmins. The homage offered to bulls and cows in Egypt paled before the veneration of the cow in India.

Premeditated killing of a cow was held on a par with the murder of a Brahmin, the vilest crime in India, and was punished, accordingly, by death. If a cow was killed by accident, the culprit could expiate his guilt in the following manner: he shaved his head and for a month had to live with cows, eating nothing but raw barley



A representation of sacred Apis.

and covering himself with the hide of the cow he had killed. For another two months he was allowed to eat, every other evening, a small quantity of other grains without salt. He had to follow the cows about, trailing behind and breathing the dust raised by their hooves.

"Moreover", read the holy law, "the criminal must, on expiration of his term of penance, pay a fine of ten cows and one bull, or, if he has not the means, give all of his property to the Brahmins."

All these precepts were strictly observed. The cult of the cow is as strong today in India as it was centuries and millennia ago. India has one of the world's biggest cow populations, 200 million head. Experts have calculated that from the sale of beef it could have an income equal to its entire defence expenditure. But the trouble is that this beef can neither be sold nor eaten by the Indians themselves. The cow remains a sacred animal, while millions of Indians live on the brink of starvation. They cannot even use the milk of these cows, for 90 per cent of them have never been milked in their lives.

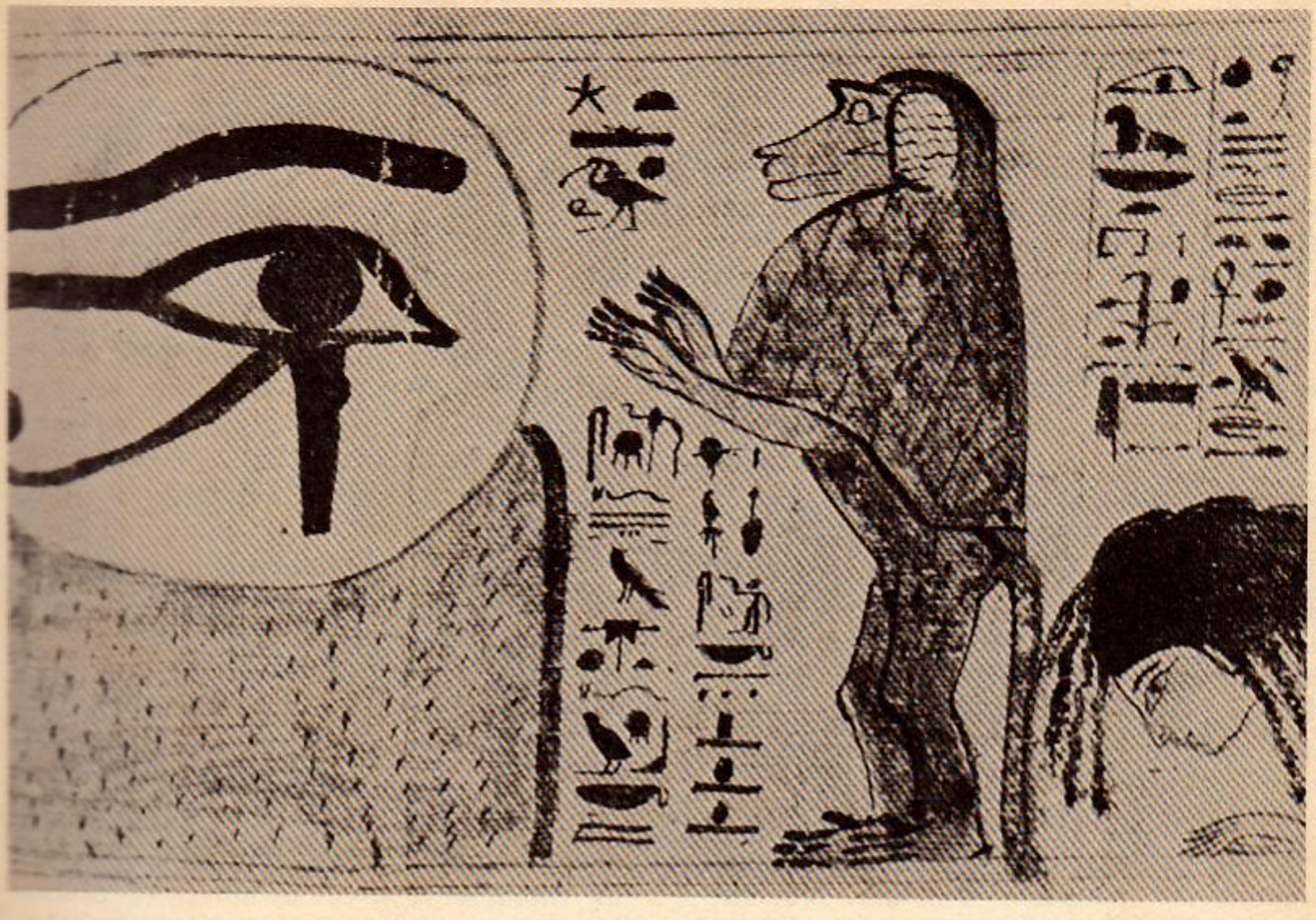
Progressive Indians are well aware of the absurdity of the situation, but so far religious prejudice is holding its own.

However, the cow is not sacred everywhere in India, but only in those areas which profess Brahmanism. Buddists can kill cows without any scruples, because they revere not the cow but the white elephant as the sacred animal. It is into such an elephant that the souls of priests and saints, heroes and rulers are supposed to transmigrate, the white colour of the hide in itself being proof of virtue.

A baboon, an ancient Egyptian sculpture dated 14th century B. C.

Only powerful sovereigns could afford to own a white elephant. Of all their titles, the one they cherished most was the "Owner of a White Elephant". Kings declared war on one another and maintained bloody feuds for many years for the sole purpose of having in their stable an albino elephant adorned with gold rings and covered with a gold netting, and of adding the coveted title of the "Owner of a White Elephant" to their lists of titles.

Some species of monkeys are also held sacred in India. There are still temples where monkeys run wild and are lavishly fed (this, let me remind



The baboon held an important place, it appears, among Ancient Egypt's sacred animals.

you once again, in a country where millions of people go hungry!). There are special hospitals for monkeys (when thousands of people are unable to receive any medical aid at all!). And despite the havoc these animals wreak in the surrounding fields, they enjoy complete immunity and cannot even be hit or shooed off. These monkeys sometimes descend upon cities, where they do what they like, stopping cars and literally robbing their passengers.

The killing of a monkey by a foreigner caused such an explosion of indignation that the culprit would have to leave the country. Even today "disrespectful" treatment of a monkey is frowned upon by religious Hindus.

Victims and Oracles

Many legends connected with animals were current in Ancient Greece and Rome. The Romans believed, for instance, that Jupiter came down to earth in the form of an animal: a bull on one occasion, a swan on another.

Many Greek and Roman gods were symbolised by animals. Jupiter, for instance (the Greeks called him Zeus), was symbolised by an eagle, Juno (Hera to the Greeks) by a peacock, Minerva (Athena) by an owl, Venus (Aphrodite) by a dove, Mars (Ares) by a rooster, Nepture (Poseidon) by a horse and Aesculapius (the Greeks called him Asclepius) by a snake.

Greek and Roman myths contained many monstrosities: the Stymphalian birds with brass wings, the winged steed Pegasus, fantastic dragons and centaurs, the fierce dog Cerberus, a doe with copper legs, a many-headed hydra and the serpent Cadmus.

Real and fantastic animals are met in profusion in Greek and Roman legends and myths. In some, people are turned into animals, in others, animals become people. Still, neither in Ancient Greece nor in Rome were animals worshipped, though they were respected for their important services to mankind. For instance, a she-wolf was believed to have suckled Romulus and Remus, the founders of Rome, and geese were credited with saving Rome from foreign invaders. Still and all, animals were not deities but only sacrifices offered to gods.

Sacrificial offerings to gods were widespread in almost all countries and among all peoples. But the Ancient Greeks and Romans evolved an elaborate procedure for ritual sacrifices.

There were strict categories of sacrifices. Some were offered to gods in thanks, while others were a form of expiation for a sin. The "techniques" also varied. In the first case, for instance, only the entrails of the sacrificial animal were burned, while a portion of the meat went to the priest, and the rest to the owner of the animal. In the second case, the person who sought to expiate his sins by means of a sacrifice received nothing at all. The meat was appropriated by the priest.

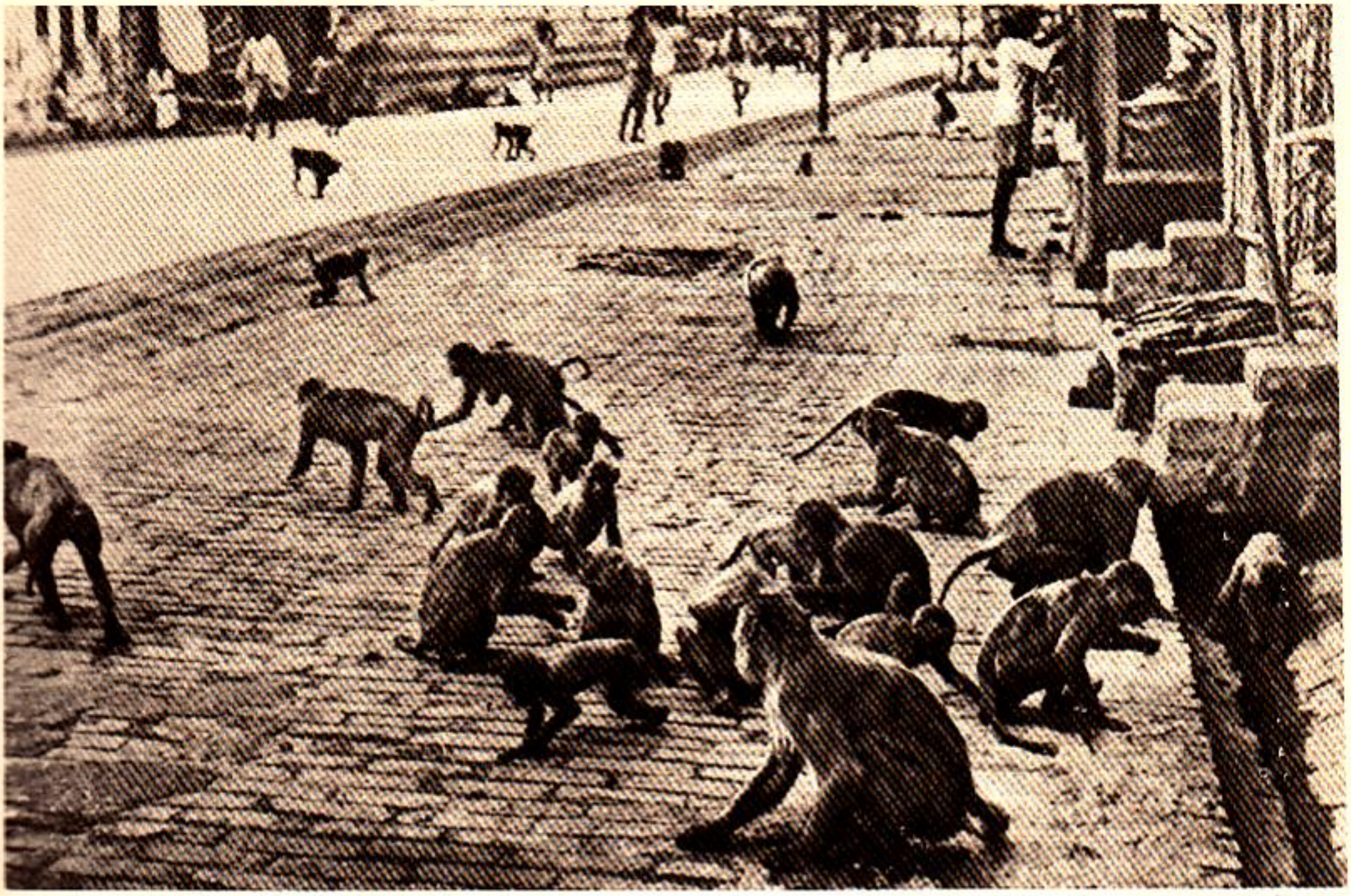
The choice of animal for the sacrifice was also a matter of grave importance to both Greeks and Romans. In the first place, only domestic animals were sacrificed — apparently wild ones were considered not to the gods' liking. Secondly, the animal had to be young, healthy and well-fed. Next, each god was supposed to have a preference for a certain animal. On the whole, animals most often used for sacrifice were cows, bulls, and calves, sheep and rams, goats and pigeons. Still, every god was supposed to have a favourite animal.

The rules of the procedure were strictly observed. Before killing the victim, a special mixture of fried grains and salt was poured on its head, then it was adorned with a special wreath, while bulls, rams and he-goats had their horns gilded. The person making the sacrifice also wore a wreath. If the sacrifice was intended for gods living in the heavens, the animal's head was raised aloft before the killing, but if it was for the gods of the nether world, the head was lowered.

Gradually, more and more elaborate details were thought up — after all there were great numbers of priests and they had to supply themselves with a steady income. If initially the ritual sacrifice was performed by one priest, later, there was an entire "team" engaged in it, one giving orders, another stunning the cow or bull with a cudgel, still others cutting its throat, lighting the fire, skinning the animal, and so on.

The priests noticed that in some cases the animal's entrails or skin burned quickly and in others, slowly. The smoke sometimes rose straight up or veered to right or left, and the flames leapt differently. They concluded that all this indicated the god's attitude toward the sacrifice. Interpreting the god's will became a rich source of income for the priests. Later, they also took to divining from the behaviour of live animals.

With time, these oracles assumed



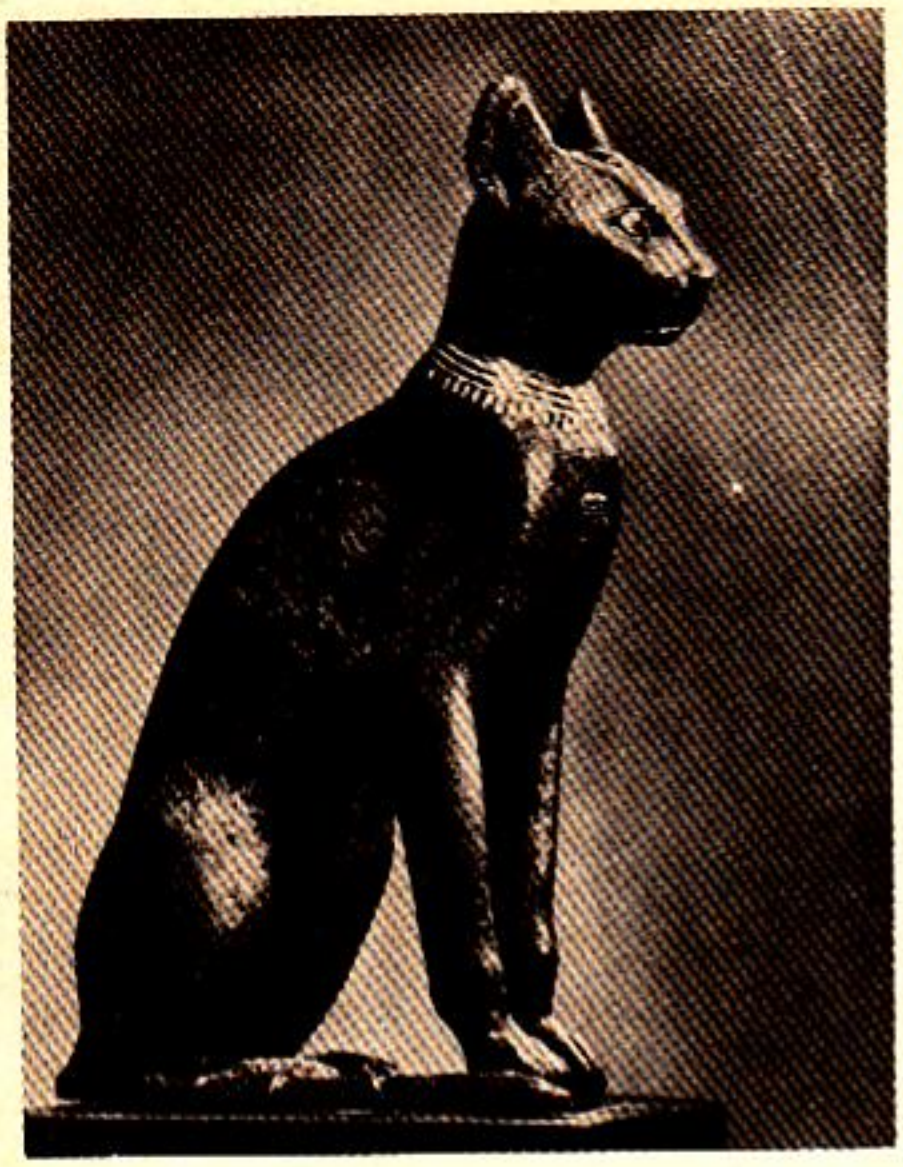
In India monkeys are held in universal respect to this day. And they feel as much at home in a city street as in the forest.

vast powers and were in a position to revoke any law, dissolve any assembly, or postpone a military campaign. They were held in the greatest esteem and enjoyed complete immunity. And all they had to do was foretell the future on the basis of animals' behaviour.

The procedure of foretelling the future was elaborated by Roman priests (they were called augurs) in minute detail. They divided birds, for instance, into two categories — those that foretold the future by their singing, and those who did it by their flight, the movements of their wings and so on. Here, too, there were numerous subtleties — the same sounds or movements received different interpretations depending on the circumstances or the season. It was also considered important from which direction the prophetic animal appeared — from right or left. Also, the appearance of one and the same bird in different circumstances meant different things.

For instance, the arrival of a raven at night was a bad omen, but if the bird attended a wedding ceremony, it augured a happy marriage.

An owl in some cases was a good and in others an ill omen. The Greeks rejoiced when they met an owl on the road, for according to their views, an owl was a messenger of Athena and a meeting with it promised success to a traveller.



This proud ancestor of our domestic cat did not stoop to hunting mice and rats. It "deigned" to accept the homage paid it by the Egyptians and paid them back by helping at hunts as well as any dog.

Ancient Greeks portrayed "the Bird of Wisdom", the owl, even on coins and medals.

Swallows, on the other hand, portended misfortune. If a swallow winged its way above the city square in Athens during a popular assembly, the assembly broke up there and then.

The Romans believed that the howling of dogs and wolves was a bad omen. The same applied to a snake making its way into a house. If a snake made its way into a temple, that was a foretoken of national calamity.

The priests did not confine themselves to observing the behaviour of animals in natural conditions. In special temples they kept certain animals allegedly able to divine the future. These were even taken along on military campaigns. In Rome this ability was ascribed primarily to chickens. Augurs foretold the outcome of various undertakings on the basis of the chickens' behaviour, their briskness or sluggishness, their appetite, their clucking, etc. Of particular significance was their manner of feeding at sunset: if the chickens pecked the grain with a will, it promised success, if they were listless, conditions were not propitious. On a number of occasions, battles were postponed due to the sacred chickens' lack of appetite.

The prestige of chickens rose higher than ever after the following incident in the First Punic War. On the eve of the decisive battle the augurs informed the consul Claudius Pulcher, who commanded the Roman fleet, that the sacred chickens kept on board of one of the warships refused food altogether. It did not occur to anyone that the chickens were simply seasick — the fact was taken by all and sundry as an evil omen. Claudius, however, refused to heed the warning and postpone the battle. "Let them drink then," he said and gave orders to throw the chickens

overboard and went along with his plans. However, the outcome of the battle was, in fact, preordained. The Roman soldiers and sailors were so shattered by his handling of the sacred chickens that they offered practically no resistance to the Carthaginians, and the battle was lost before it began. What was the point of fighting, they must have reasoned. The sacred chickens had foretold defeat, and had been thrown overboard to boot. One might just as well submit to fate!

As is often the case with superstitious people, they confused cause with effect. The Roman fleet was defeated not because the chickens had foretold the disaster, but because the Romans allowed their superstitions to prevail over common sense and affect their fighting capacity. But in olden times, no one attempted to sort out cause and effect — all the people were able to see was that the prophecy had come true. After that, the chickens' predictions were heeded more than ever.

Hens and roosters were held sacred in other countries as well. In India they were called "sun birds" — for did not they crow at sunset? This crowing, the Hindus believed, was a warning to people that evil spirits had overcome the sun and were abroad. And in the morning, the hens and roosters proclaimed that the sun had got the better of the evil spirits.

From India, chickens made their way to China. That was more than three thousand years ago. To begin with, the Chinese were sceptical about their divining powers — the birds seemed too homely to be informed about the movements of evil spirits. The Emperor Fu-shih had to issue a special decree to force the population to keep chickens.

The author of this bas-relief was undoubtedly convinced that an animal such as this actually existed.

In Persia, on the other hand, chickens were accepted as augurs at once and given even greater homage than in India. The soldiers of King Darius I brought them, among various other trophies, from a war against India 2,500 years ago, along with their reputation as "sun birds" and legends that they were the sun's allies in its struggle against evil spirits. The Persians took the legend to heart and willingly obeyed the king's decree commanding that a rooster should be kept in every household and prohibiting the killing of this bird.

Before long, chickens "occupied" all of Persia, and some five centuries later, made their way to cities on the Black Sea coast, and from thence to Europe. There, too, they were greatly respected. It was believed that evil spirits were in awe of roosters, and for this reason, their representations were

put up on spires of towers and on roof-tops of many houses — for protection against evil spirits.

Weathercocks are still to be observed on old buildings. Sometimes they are put up on new cottages in the country, but today this has become a mere tradition.

Love and Hatred

Man's attitude to various animals changed many times in the course of centuries. From indifference or practicality, he went on to adoration and deification, and then to hatred. Ancient Egyptians, for example, highly appreciated the cat's ability to destroy rodents. The cat was much superior in this respect to the grass-snakes and weasels they had kept in their houses before. These proved unable to cope with hordes of rats which invaded Egypt from Asia. So the cat, a very useful animal, was ranked as a sacred animal and one of the most important ones, too. The goddess of the Moon, fertility and childbirth, Bast herself, was portrayed by the Egyptians as a woman with a cat's head.

Sumptuous temples were built to this goddess, where cats were kept in luxury and fed the choicest of foods. They had their own priests and votaries, more numerous as a matter of fact than any other sacred animal could boast. According to the Greek historian Herodotus, the festival in the city of Bubastis, which had a temple dedicated to cats, was attended by as many as 700 thousand, who brought their offerings to the goddess in the shape of figurines of her made of gold, silver and bronze and adorned with precious stones.

The overfed and lazy cats kept in the temples naturally disdained such

The legendary Greek hero Hercules accomplished twelve labours. One of them was wrestling with the terrible Nemean lion. This is a representation of the deed on an old Greek vase.

lowly occupation as catching mice. But the priests were no longer concerned with their useful activities — they sought out their god-like qualities. And they found quite a few of these. The cat, it appeared, had affinity not only with the goddess of the Moon, but also with her mighty brother, the great Sun God Ra. The priests pointed out many signs of kinship between this notoriously nocturnal animal and the day luminary. One of them was the cat's eyes. The higher the sun ascends, the narrower the pupils of the cat's eyes become, and vice versa. When the sun sets and darkness falls, the cat's pupils become quite round, like two little suns. This alone indicated, the priests argued, that the cat is the sun's kin. Such a creature deserved not only worship but carėful protection. During a fire, for instance, the Egyptians were more concerned with saving the cat than their earthly possessions.

There is a legend alleging that it was on account of cats that the Egyptians lost their battle to the Persians. The Persian King Cambyses, while preparing to attack an Egyptian town, collected a great multitude of cats and gave one to each of his warriors to hold when they attacked the positions of the Egyptian army. The Egyptians surrendered, for fighting the Persians meant killing a certain number of these sacred animals, and this they could not possibly do.

The killing of a cat, even by accident, was punished by death, often meted out by an indignant mob. Even the intervention of the pharaoh sometimes failed to save the culprit.

The death of the cat living in the house was considered a great bereavement. The family shaved off their eyebrows and cut their hair as a sign of mourning. The dead cats were embalmed and buried in special coffins having the shape of a cat. These coffins were often made of gold or silver and richly encrusted.

Cats were buried in special cemeteries. In 1860, a cat cemetery which held the remains of more than 180 thousand cats was discovered in the vicinity of Beni Hasan in Egypt.

The cult of the cat in Egypt persisted for many centuries. Even when ancient Egyptian culture was forgotten and Islam had become firmly established, with the Arabic language and Arabic culture holding sway, cats remained sacred, or at any rate were greatly revered.

As late as the 13th century, for instance, the Sultan El-Daher-Beybars, a passionate lover and worshipper of cats, bequeathed a huge orchard in the environs of Cairo for the sole use of these animals.

The orchard was, indeed, put at the disposal of cats, and all income from it went to a special cat fund and was used to procure food for the cat population.

So we see cats had an easy time of it in Ancient Egypt. Nor were they any worse off in Southern Europe. In Ancient Greece and Rome the cat was revered as a symbol of love of freedom.

Quite a few customs have come down to us from those times when the cat was a sacred animal, or at least one which enjoyed universal respect.

For instance, English sailors still believe that a cat on board ship, especially a black one, brings luck. And during shipwreck, cats were the first to be rescued. In coastal regions of the county of Yorkshire in England, the belief is still held that a black cat in the house protects its master from misadventure at sea.

The English, unlike Russians, do not think that a black cat running across the path is a bad omen. On the contrary, it is a good sign. If a cat comes into a house or a room, it portends good news, and if it sneezes during a wedding anywhere near the bride, the marriage promises to be a happy one.

Formerly, black cats were held in esteem in Russia as well. It was believed, for instance, that such a cat could give relief in some illnesses. If one developed a sty, it was enough to brush the eye with the tail of a black cat to cure it. The tail of a three-coloured cat was supposed to protect one against warts. If one said, "Gesundheit!" after a cat sneezed, he got cured of the toothache.

If the cat washed its face, you could expect guests. And when it sharpened its claws, bad weather was sure to set in.

But these omens were mere remnants of the cats' former good reputation. Cats, particularly black ones, have long been considered a symbol of evil in all European countries, a notion which persists up to the present.

Cats' good fortunes in Europe ended abruptly some 700 years ago, during the Middle Ages, when the Catholic Church, out to destroy the influence of the East, also turned against animals worshipped in the Orient. The cat was among its first victims; cats were condemned as the personification of the devil and witches.

Ostensibly, there were plenty of reasons for this accusation. Where did the cat go at night, and what were its nocturnal pursuits? Why was its tread noiseless? Why did its eyes glow in the dark? Was it the fire of hell burning there by any chance?

The reply to all these questions supplied by the church was that the cat was the embodiment of evil, Satan's own accomplice. People associated with the devil — witches and sorcerers — often assumed the visible form of a cat. To do that, they had to partake of a special dish prepared from a cat's brains and rub their backs with a bit of umbilical cord from a newly born infant.

Naturally, the clergy felt it incumbent on them to do something about these monstrous creatures. So cats were tortured on a par with women who were accused of witchery and of taking on the guise of black cats. Thousands of women were thus executed in the Middle Ages on the charge of having dealings with Satan through cats. Often the cats were burnt alive together with the unfortunate "witches". There was a custom in many European countries of staging annual round-ups of witches, that is of catching and destroying cats. In Slavic countries, large numbers of cats were drowned on St. John's Eve, when the witch-plant, the fern, was believed to flower. Elsewhere they were dropped from high towers or burned at the stake. In the Netherlands, there was a special "cats' Wednesday"— when cats were caught and destroyed en masse. As late as last century, this Wednesday was marked in Flanders by the dropping of numerous cats from the tower in the town of Ypres.

Such is the dramatic story of the cat, goddess and witch, an animal both much beloved and virulently hated, a characteristic and far from unique story.

Animal-People and Animal-Devils

Several centuries ago a knowledgeable French monk asserted that the

devil could assume the form of any animal at all.

It was widely believed that the purpose of such transformation was to frighten people, do mischief, or to transport witches to a sabbath and back. In such a case, demons assumed the shape of rams or he-goats. Actually, Satan himself was reputedly fond of assuming the shape of a huge goat.

Witches, as we know, preferred the guise of a cat, which made it easy to penetrate any house, listen in to conversations, nose out things and play nasty tricks. And if a particularly vile trick was planned, the operation was discussed by a gathering of cat-witches somewhere in the garret.

Of course, a cat had its limitations as regards damage. It could not, for instance, spoil cabbage in the cellar. But for that particular purpose, a witch could turn into a hare — also a favourite disguise.

A special term existed for transformations into a wolf — lycanthropy. Wolves, so the prejudice held, were also much favoured by sorcerers. Hence the name "werewolf" current in the English language. But the belief was also widespread in France, where in the 16th century, a certain Gilles Garnier was sentenced to death in the town of Dol for "devouring numerous children while in the guise of a werewolf".

In the 17th century, the Senate of the Duchy of Savoy (there was a state of that name where France adjoins Italy today) sentenced to death several alleged sorcerers, one of whom, Glaude Garot, was reputed to be a werewolf. In Germany and Russia, lycanthropy was also widely believed in.

To be sure, specialists asserted, not all werewolves were dangerous to man, for some had been transformed into wolves by evil sorcerers. Once, a man who met a wolf in the wood, it was alleged, was told a curious story by the beast: an abbot who had magical powers cursed a village. Ever since then, the people living in that village turned into wolves now and then and ran off into the forest. There they stayed for seven years and, if not killed, upon expiration of the term, returned to their home village and resumed their human shape, while others in their turn became wolves and went off into the forest for another term of seven years.

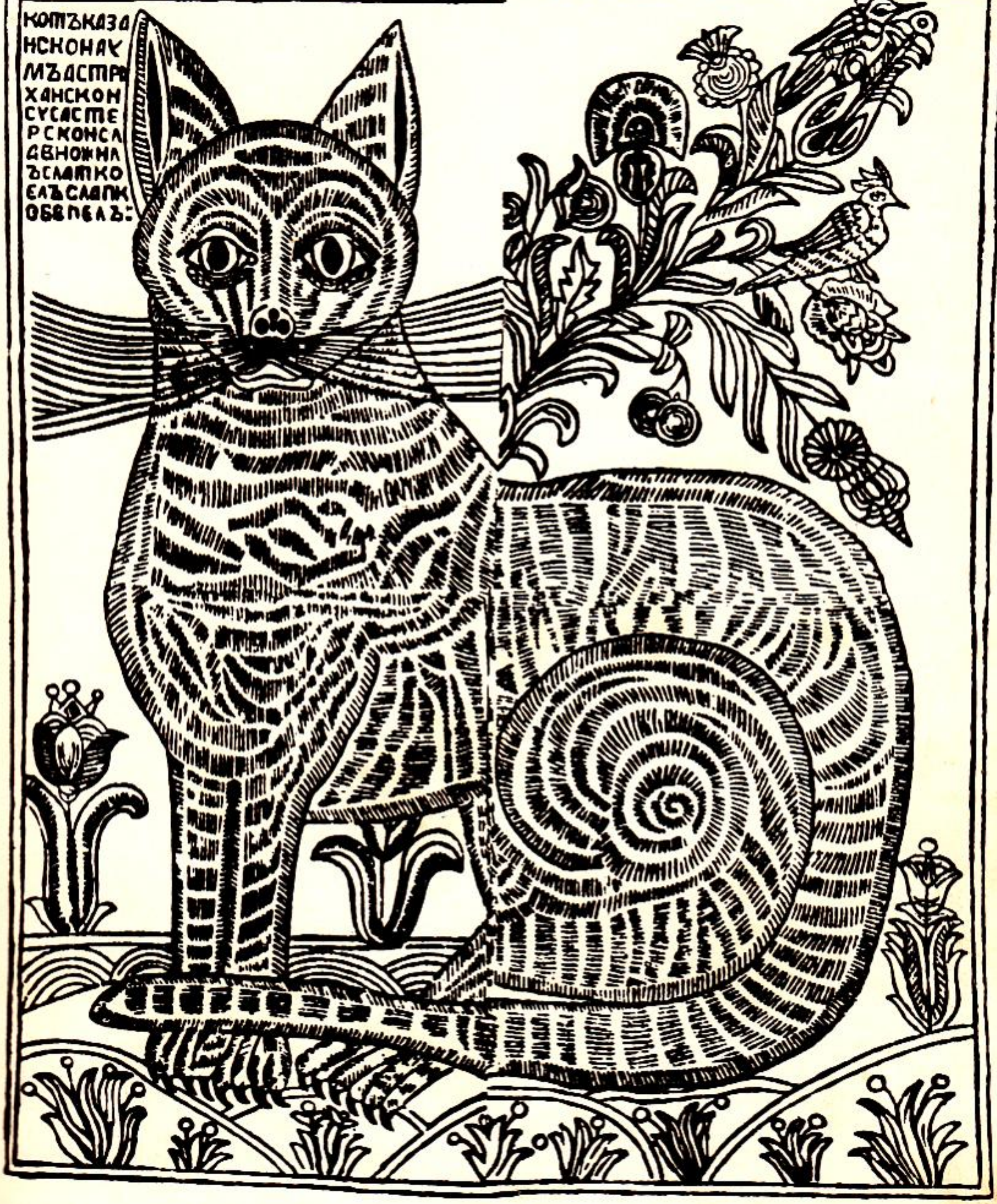
Our ancestors in Russia also believed in such "unwilling werewolves" and thought it was they that howled in the night, bewailing their sad fate. As for the sorcerers who transformed themselves into wolves, they derived malicious pleasure from their evil doings and never uttered any sounds. They attacked people, cast spells on farm animals, and put curses on whole villages. Since they could assume the form of any animal at all, life must have been pretty frightening in those times, for you could never be sure that the dog in your yard, a chicken, or even an insect were no some devil in disguise.

Was that a fly sitting on the wall or devil in the guise of a fly? What mischief could it be planning? Was he planning to do you harm? Or perhaps it had already turned the cow's milk?

Man would have lived in constant fear if he had believed in evil spirits alone.

The Power of Words or a Curse on Eels

It was universally believed that there was an effective remedy against the evil spells cast by sorcerers. All one



The cat did not reach Russia until rather late in the day. But once it did, it soon became prominent in man's life. A Russian folk print of the 18th century.

had to do was dedicate the animal in question to some saint or other. Moreover, pigs dedicated to St. Anthony, for instance, grew up to be fatter and more intelligent than others. Nobody dared to harm them. Other saints were the protectors of horses, rams and goats.

Superstitious people who believed that evil spirits assumed the appearance of animals could take recourse to charms. There was such an incantation, for instance: "In the name of your Creator, I adjure you to be rooted to the spot; should you fail to fulfill this command, I shall curse you as you have been cursed by the Lord."

Of course, not just anybody could make the invocation effective. One needed to be a priest at least. But the greatest effect was achieved by a holy man: the werewolf would once and for all discontinue his harmful "anti-social" activities.

Accounts of such "miracles" are contained in ancient chronicles and books.

In Valle d'Aosta, a region of Italy, moles had multiplied to such an extent that farming began to suffer. The peasants appealed to Bishop Grat, who was famous for his saintliness and had already performed several miracles. He intoned a prayer and ordered the moles to go away. They did not obey him, however. Then he was endowed by the heavens with special powers and laid a curse on the intractable animals, after which they all died.

A similar miracle is ascribed to Bishop Hugues of Grenoble, who was appealed to by peasants whose lands were infested with snakes. The bishop laid a curse on the creatures, who, it is true, did not die but, so the chronicle asserts, lost their venom.

Numerous cases when holy priests laid curses on animals are cited in old books. These episodes demonstrate, on the one hand, the power of the holy fathers, and on the other, the animals' ability to think and obey orders, disobedience being punished by death.

Today we know very well that no curses or incantations can possibly affect animals in any way. Yet these "miracles" were actually there for all to see. Why were the curses effective? How can it be that people continued to believe in the priests' supernatural powers? The explanation is that the holy

A medieval trial. Who is going to be pronounced guilty: the man or the dog? Or perhaps both? An engraving dated 1556.

men were often astute people who did not spurn the aid of reason while working their "miracles".

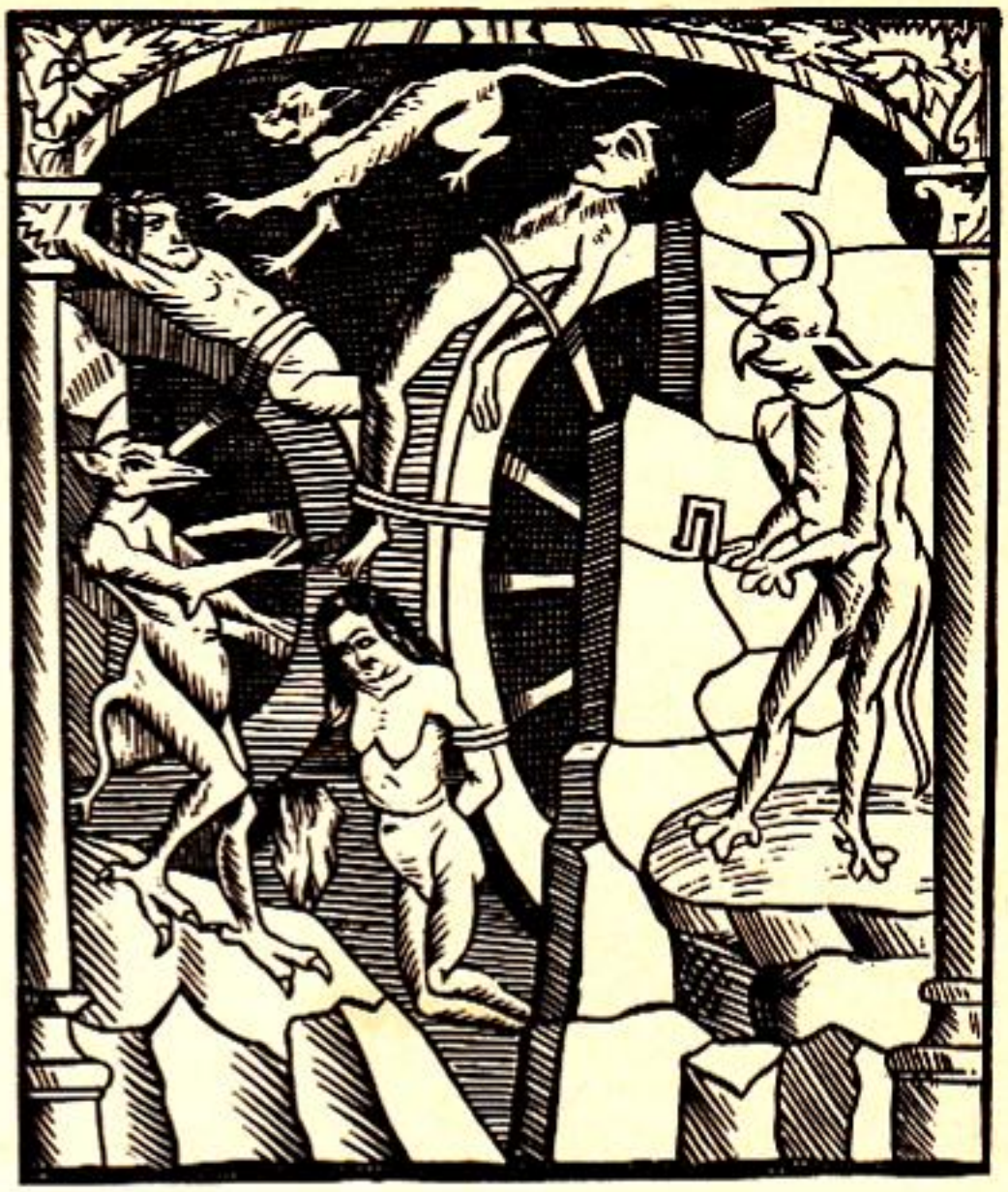
Here is an example of a "miracle" that was subsequently explained by scientists.

In the 17th century there was a sudden influx of eels in Lake Geneva. The multitude of eels fouled up the water in the lake, and the local people were in serious danger of losing a source of drinking water. So they appealed for help to the Bishop of Lausanne. The bishop only gave in to their pleadings after a long hesitation. Even so, he was in no hurry to start his exorcising activities, but would go strolling along the shore of the lake instead, peering into the water. He seemed to be waiting for something, and the people did not dare to press him. At last the day arrived when the bishop appeared on the shore of the lake in his resplendent robes and with a large retinue. He raised his arms, chanted suitable prayers, and ended by anathemising the eels.

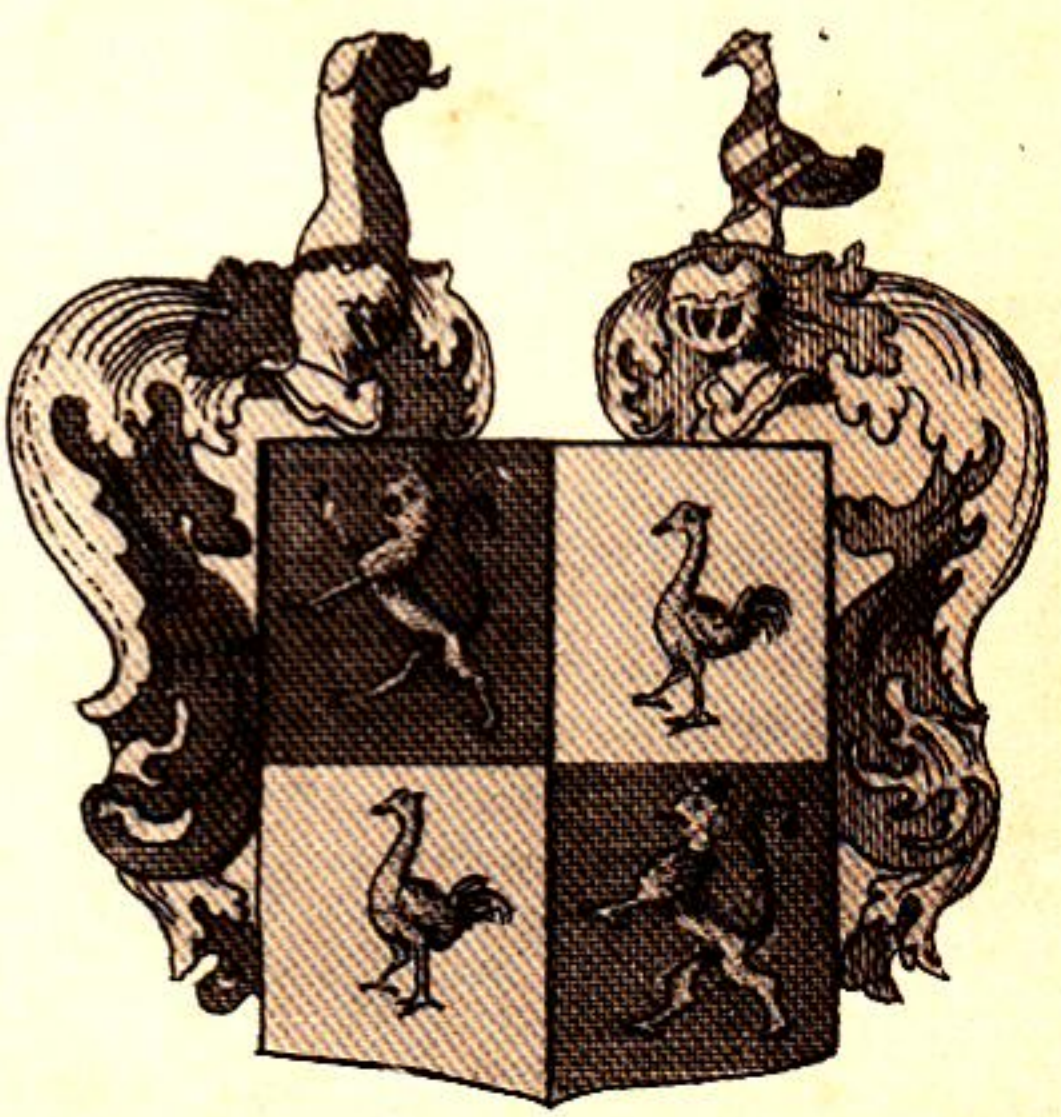
Before long people began to notice dead eels floating on the surface of the water. So the curse had been effective! The eels were dying!

News of the miracle spread throughout the country and even beyond its borders. Indeed, wasn't it a miracle for all to see?!

But the miracle had a very prosaic explanation. The Bishop of Lausanne had spent a considerable time watching the eels. He was a fairly well educated person for his time and he realised that if the eels were multiplying at such a rate, they were soon bound to begin dying from lack of food or some disease. And that was exactly what happened. Once he caught the first signs of an approaching pestilence, the bishop hastened to curse the eels. And in a few



If the person on trial persisted in denying his guilt, he was subjected to torture. An engraving dated 1529.



In the Middle Ages animals were not always persecuted. Their symbolic representations appeared even on coats-of-arms.

days' time, the pestilence reached such proportions that the "effect" of the curse became obvious to all.

It is quite likely that the holy man who cursed the moles acted along the same lines, waiting until the moles had started dying — either of starvation or some disease — and then cursing them.

As for the holy man who rid the peasants of poisonous snakes, this "miracle" is even more easily explained. He simply knew they were harmless grass-snakes, while the ignorant peasants made no distinction between harmless snakes and vipers, for both were crawling things which struck terror in their hearts. After the curse, people became bolder and realised that the snakes had been "deprived" of their venom.

Still, potent though the word of a holy man was, sometimes people had to take recourse to stronger measures, and then animals were put on trial.

Judges, Defendants, Lawyers

Trials of animals were a common occurrence in medieval Europe up to the eighteenth century.

Animals, birds, reptiles and insects were put on trial. The procedure was strictly observed: the defendants were interrogated and even tortured. Counsels for the prosecution and the defence were given a chance to plead their case before judges. Nobody saw anything strange in it, for it was universally believed that animals acted rationally and therefore had to answer for their misdeeds according to the letter of the law.

All trials of animals can be divided into two categories — "civil" suits, so to speak, and "criminal" proceedings. The first category was characterised by gentleness and "justice" shown "God's own creatures". The sentence was preceded by the following appelation: "You are God's own creature and I respect you. The earth belongs to you as well as to me, and I mustn't desire your death. But you do me harm, you infringe on my heritage, you ruin my vineyards and devour my harvest. In short, you deprive me of the fruit of my labours. Perhaps I deserve it all because I am merely a miserable sinner. At any rate, the right of the stronger is a despicable right. I shall explain your guilt to you, I shall plead for God's mercy, I shall appoint you a place where you will be able to live and there you will have to go, and if you persist, I shall anathematise you."

Still, when these heartfelt exhortations failed to work, there was nothing left but to take the culprits to court. The courts, however, were quite lenient with agricultural pests and were in no hurry to pronounce a death sentence upon them. In 1479 the populace of a certain district in Switzerland lodged a complaint against the larvae of the May bug which destroyed their woods and orchards. The larvae's lawyer argued with the judges as to whether or not the May bug had been taken on Noah's Arc. The dispute lasted for two years, during which the larvae continued their destructive activities unhampered.

In the 14th century, the townsfolk of Chur in Switzerland sued white worms. When the latter failed to make an appearance in court, the court appointed counsels for the prosecution and defence and started the proceedings with all formalities observed. The decision of the judge was that "since the above-mentioned worms were God's creatures and had the right to live, it would con-

sequently be wrong to deprive them of their means of subsistence", and that they were to be moved to a wild wooded locality where they could live in peace, doing no harm to people.

Several years later the citizenry of the same town instituted proceedings against the Spanish fly. The judge appointed not only a counsel for the defence but also a warden, and the two succeeded in getting a ruling that decreed the transfer of the Spanish flies to another district. The people were made to allot quite a sizeable territory where these insects could live undisturbed.

An even more famous trial of insects took place in Switzerland in 1545. The eloquence of the defending counsel and his clever arguments resulted in a court decision to move the bugs in question to a different locality, and a specially appointed commission spent a long time choosing the site. In the end they drew up a document confirming the bugs' right to use an area of fairly fertile land. It was with great difficulty that the local people obtained permission to walk across this area, and only on condition that "no harm were to be done to the bugs' pastures". Yet the bugs never moved to their new territory (nor, naturally enough, did the other insects, the court decision notwithstanding).

At that time, a war flared up between two feudal lords, and troops passed over the site assigned to the bugs. The bugs' lawyer immediately appealed against the decision of the court, arguing that the area was no longer suitable for the bugs' habitation.

No less humane were trials of rats. The French barrister Barthélemy Chassanée made a career out of defending mice and rats. In 1480, he won a case by explaining to the court that his clients were unable to appear in court because their homes were scattered all over the country, and anyway, they were just holes where the news of the summons had not been able to reach them.

The court decreed that the summons should be made known to all mice in all villages. Still, the defendants failed to make an appearance. Their counsel again found a plausible excuse, saying that the mice had to cover many miles across fields, woods, ravines and swamps, their life threatened at every step by cats, foxes and owls. He made an ardent speech, arguing that it was not fair to condemn a whole race, and that the court had to establish the individual guilt of each animal. Since this was not feasible, the case was dismissed.

True, not all lawyers were so adroit in pleading the cases of their clients. Sometimes mice and rats were sentenced to eviction. But the court invariably issued them with documents of safe-conduct, protecting them from cats along the way.

There were "civil" cases brought against animals as late as the 18th century. In 1713 termites were brought to trial in Brazil for eating the flour and gnawing away the wooden supports in a monastery cellar. The trial, held in strict accordance with the accepted procedure, ended in a decision that the termites must leave the monastery precincts and settle in a field specially assigned to them. The termites naturally disobeyed. And the monks had to leave them alone — after all, termites had also been created by God and served him in their own way. Killing them was out of the question.

So much for "civil" suits. The tenor of "criminal" proceedings was different: here the judges were not as lenient, and most of the defendants were executed on a gallows or burnt at the stake.

Between the 12th and the 17th centuries, nearly a hundred death sentences were meted out to animals in France alone. Such trials were also held in Italy, Germany, England, the Netherlands, Sweden and Switzerland.

In the 13th century, a pig was sentenced to hanging in France for devouring her litter.

In 1314, a bull was sentenced to the gallows for attacking a man.

In 1389, a horse was executed for killing a man.

In 1442, a wolf was tried in Zürich. It was brought in a cage which was set in the central square where the trial was held. The wolf was accused of killing two little girls. He found defenders, too, but was still sentenced to death and executed.

In the 15th century, a stallion was put on trial on the charges of sloth and bad temper. By decision of the court, it was killed with a cudgel.

In 1796 a bull convicted of causing a cattle epidemic was buried alive in Germany.

This list could be prolonged indefinitely.

There were other punishments inflicted on animals besides the death sentence. They could be excommunicated, for instance. This was done by the Bishop of Lausanne in 1120 to caterpillars and field mice who refused to obey a court order. A year later, he excommunicated flies that came inside the church.

Nor were animals always defendants in court cases. Considered capable of rational thinking, they could be witnesses as well.

If, for instance, a man was attacked by burglars in his home and no humans could bear testimony to his words, he could produce as a witness a cat, a dog or a rooster.

To be sure, these witnesses ran the risk of finding themselves in the dock and being severely punished if the court established that they had witnessed a crime and failed to call for help. As often as not, such witnesses were executed. Not infrequently they were also tortured with a red-hot iron, a whip, or some refined instrument of torture favoured by the medieval Inquisition. Their cries in this case were regarded as admission of guilt.

Not all animals, however, were liable to legal responsibility and punishment.

In some countries, bulls, stallions and rams were under special protection and enjoyed immunity. Not that they were officially allowed to trample down crops, but they were not made to answer for it, and the owner of the ruined field could not even sue the master of the animals. The only thing he was permitted was to chase the offenders off his field or garden with a switch.

Not so geese, ducks and chickens, who were made to appear before a court of law for such misdemeanors and were severely punished.

There were countries, though, where horses and cows were also tried for damage done to the crops. Usually they were executed, and their meat went to pay the court expenses.

In the Middle Ages the church gave much attention to animals, and the clerics engaged in involved "scholarly" controversies concerning them. Some held that animals were "God's own creatures" and were thus endowed with an immortal soul; others denied their right to an afterlife and were full of pity for these creatures destined to a short lifespan on earth and no promise of heavenly bliss; still others believed all animals to be demons.

TO SUM UP THE PREVIOUS CHAPTER AND INTRODUCE THE NEXT ONE

Centuries and millennia passed. Humankind has grown to adulthood and wisdom. No one worships animals today. But traces of the long-forgotten cult of animals, or hatred for animals, can still be found here and there. And I do not mean tribes which still remain at a low level of development and still practise hunting magic.

A group of researchers led by the American professor E. Caldwell took a poll of 150 thousand people in eighteen countries as to their attitude to superstitions. It was established that some four thousand omens and signs were still alive in these countries. Only three persons out of ten declared that they believed in no signs whatever. Four people out of ten admitted that they had some belief in superstitions for all that they understood their unreasonableness.

Superstitions about animals have proved very tenacious. This can be explained by the important role animals once played in man's life and by his inability to understand them.

On the other hand, a study of rock paintings reveals that primitive men had a very good notion of the animals' habits and even their anatomy. The poses of the animals represented are very natural and the wounds depicted are such as to be unerringly fatal. We cannot say that Cro-Magnon people sought to pierce an animal's heart — for they had no notion of the heart's existence and function. But centuries of hunting had taught them that a spear thrust under the left shoulde-blade was immediately effective.

Necessity forced our ancestors to learn animals' habits and natures, for without this knowledge, they could not have tracked them down, lured them into traps, or chased them to the place where other hunters from the tribe were sitting in ambush. Excavations of primitive men's encampments show that the flesh of beasts, birds, and fish was prominent in their diet. Their so-called "kitchen middens" always contain many animal bones.

The Neanderthal man who lived some 100-40 thousand years ago at first settled in the open, because the climate was mild. Then the Ice Age set in, and the climate got increasingly harsher. Primitive men had to seek protection from the cold, and since they could not build shelters, the only protection was afforded by caves. These caves, however, were usually occupied by large and ferocious

beasts — sabre-toothed tigers, cave bears, lions and hyenas. Men armed with nothing but stone axes and spears had great difficulty turning the lawful occupants out. To be sure, they were quite expert in wielding these weapons, but of still greater help to them was their knowledge of the ways of animals.

Hunting magic, too, is based on an excellent knowledge of animals' habits and behaviour. The dancers who represented antelopes, for instance, imitated the animals' movements to perfection.

Then came the cult of animals. Again, many animals were deified and worshipped precisely because people knew their habits and appreciated their usefulness. (Of course there were quite a few distorted notions, but that is not the point.)

Animals are mentioned frequently in ancient Egyptian manuscripts, and some of them contain very accurate information. A manuscript written some 2,500 years ago known as the Ebers Papyrus, says that the meat fly develops from a larva, and the frog from a tadpole.

And would the Chinese have been able to cultivate silkworms two thousand years ago without knowing exactly what they eat and how they develop?

As cattel-breeding developed, people's knowledge of animals increased. Undoubtedly, shepherds knew as much about cows and sheep as ancient hunters knew about antelopes. But neither were zoologists, and their knowledge could not be described as science. For the knowledge of individuals to be scientific, it has to be organised and arranged into a system, for science is systematised knowledge.

THE DUTY OF SCIENTISTS IS TO CLEAR AWAY MISCONCEPTIONS IN THE MINDS OF THEIR CONTEMPORARIES.

Professor N. K. Koltsov

2

Man Learns and Studies

A Great Greek and a Roman Patrician

The knowledge the primitive man possessed about animals did not interfere with his beliefs in good and evil animal-spirits, and in totems; nor did it prevent him from practising magic. Observations and information accumulated by the ancient Egyptians did not stop them from deifying animals, inventing the most fanciful legends about them, and having absolute faith in their truth. And the man who was the first to systematise the available knowledge about animals, the man who laid the foundations of the science of zoology, was not exempt from the mistaken views and concepts about the external world that were upheld in his time. Moreover, this man had very meagre information at his disposal, for he lived nearly 2,500 years ago, or, to be exact, between the years 384 and 322 B. C.

His name was Aristotle, and he was one of the most remarkable scholars of all times.

He was informed in the most varied fields of knowledge — philosophy, logic, history, physics and zoology. Of the 62 years of his life, 45 were devoted to scholarly pursuits. Aristotle wrote nearly 300 works. Not all of them have come down to us, but of those that did, 19 deal with animals. Of these, 10 contain descriptions of 454 species of animals. *The History of Animals*, as Aristotle entitled his work, was, of course, far from perfect and contained a multitude of errors. But by producing a work that contained descriptions of animals and observations concerning their habits, attempted a classification of animals and even offered some generalisations and conclusions, Aristotle did a great service to mankind and marked an important step in the development of knowledge about the animal world.

The History of Animals is the first known zoological study whose author drew not only on his own observations but also on the stock of facts accumulated before him. It is highly unlikely that he was familiar with the Ebers Papyrus, which described the development of a frog from a tadpole. At any rate, Aristotle gave very little attention to the frog, and when he did mention it, this was only to cite it as an example of self-generation (from slime).

On the other hand, Aristotle was undoubtedly familiar with the works of such of his predecessors and contemporaries as Hippocrates, who made a study of anatomy, Empedocles, who asserted that the scales of fish, feathers of birds and hair of animals are similar substances, and that great philosopher of antiquity, Plato, who made an attempt to describe changes occurring in the animal world.

Still though he made use of the works of others, Aristotle relied mainly on his own resources, a practice for which he had ample reason. For instance, none of the earlier scholars and none of his contemporaries had had a chance to obtain animals and plants from distant lands. Here, he had an advantage over all of them, because Alexander the Great sent him gifts of plants and animals from his campaigns in Persia, Central Asia and India. Alexander the Great felt indebted to Aristotle, who had been his tutor for many years, and this was his way of showing his gratitude.

Aristotle lived at a time when tremendous changes were under way in Ancient Greece. Athens, once a mighty sea power, had fallen into decline, and the Athenian republic had given way to the Macedonian monarchy.

Macedonia, a hilly country in the north-west of Greece, was the weakest and least developed of the Greek states. But, taking advantage of the feuds and strife between them, the Macedonian King Philip II managed to establish Macedonia's hegemony over all of Greece. This marked the beginning of Macedonia's rise. It amassed wealth and from agricultural pursuits and cattle-breeding turned to trade. However, Persia, a powerful state which held sway over the Aegean Sea, hindered the development of Macedonia's trade.

The son of Philip II, Alexander, who went down in history as Alexander the Great, not only destroyed the powerful rival but founded a vast Macedonian Empire which spread to the east as far as India and Afghanistan and to the west as far as Sicily. And he was, indeed, greatly indebted to Aristotle.

From childhood, Alexander dreamed of wars and conquests. His interests centred on swords, armour, horses, and battles. His father, however, understood that the ruler of all Greece had to be an educated man and an astute politician and not merely a warrior. So he began searching for a suitable tutor for his son.

His choice fell on Aristotle, who then lived in Athens.

Aristotle was born in the town of Stagira and at the age of eighteen came to Athens, where he joined Plato's famous Academy. Before many years had passed, he won renown as an outstanding scholar and philosopher. And so the King of Macedonia offered him the post of tutor to his son and heir.

Philip II was not disappointed, for Aristotle interested his pupil in scholarly pursuits and helped to shape the young man into an educated individual and a subtle politician. In building up his vast empire, Alexander used his sword to good account, but he was greatly aided by the knowledge his tutor had implanted in him and the skill in handling people he had learned from the great philosopher. As he went from conquest to conquest, Alexander the Great would think of his wise teacher, of their walks in the royal park and their unhurried conversations, during which his teacher unstintingly shared his knowledge with him.

As a token of gratitude, Alexander would send Aristotle a gift — an animal or a plant unknown in Greece. Aristotle was delighted by these tokens and would immediately proceed to study the novelty. Naturally, he also made a point of observing and describing animals he saw about him, though, for some reason, he omitted some of the commonest animals in Greece. But be that as it may, Aristotle created the first classification of animals.

There is much in Aristotle's works that would puzzle or entertain even an eight-year-old child. For instance, he divided all animals into two large groups — those with blood and those without. Aristotle asserted that animals which had blood also had a backbone, and those which had no blood did not have a backbone. Nor did they have a heart or blood vessels, since there was no need for them. (Aristotle placed the octopus, for instance, in this group of "heartless" animals).

Aristotle's mistakes are only too natural, in view of the insufficient knowledge men possessed in his time. The remarkable thing is that his *History* contains a lot that is true and correct. For instance, Aristotle gave an accurate enough description of the cheetah, the two-humped camel and some species of

monkeys. Aristotle was aware of the transformation cycle of insects and he knew that drones develop from non-impregnated eggs. Moreover, he did not confine himself to making a list of animals and giving physical descriptions, he produced a classification. All animals living on land were divided by him into three groups; the quadrupeds (beasts), the flying feathered creatures (birds), and worms, which included all other terrestrial animals.

Marine animals were divided into groups too, a firm line being drawn between dolphins and whales on the one hand and fishes on the other. It was Aristotle's opinion that warm blood, lung breathing and the birth of live cubs were more important features than environment. So he discerned a kinship between whales and beasts.

In this alone, Aristotle proved to be almost two millennia ahead of his time. Many centuries were to pass before scholars stopped classing whales as fishes.

Moreover, Aristotle also found distinctions among fishes, which were divided by him into two groups — fishes with a bone skeleton and with one made of cartilage.

Nor was that all. Aristotle distinguished the functions of existing, multiplying, breathing, moving and thinking. Accordingly, he divided all things into four kingdoms; inanimate objects, which merely existed; plants, which existed and multiplied; animals, which existed, multiplied and moved; and men, who, in addition to all the rest, were capable of thought.

Inside each of these worlds, in particular the animal world, he arranged species in the line of ascent — from primitive organisms to more complex ones.

Naturally, Aristotle had no idea of evolution and the changeability of all living things. It never occurred to him that a creature standing at a higher step of development had originated from those lower down. But the very fact that he noticed the "steps" and pointed them out was a great discovery.

Aristotle (384/5/-322 B. C.)

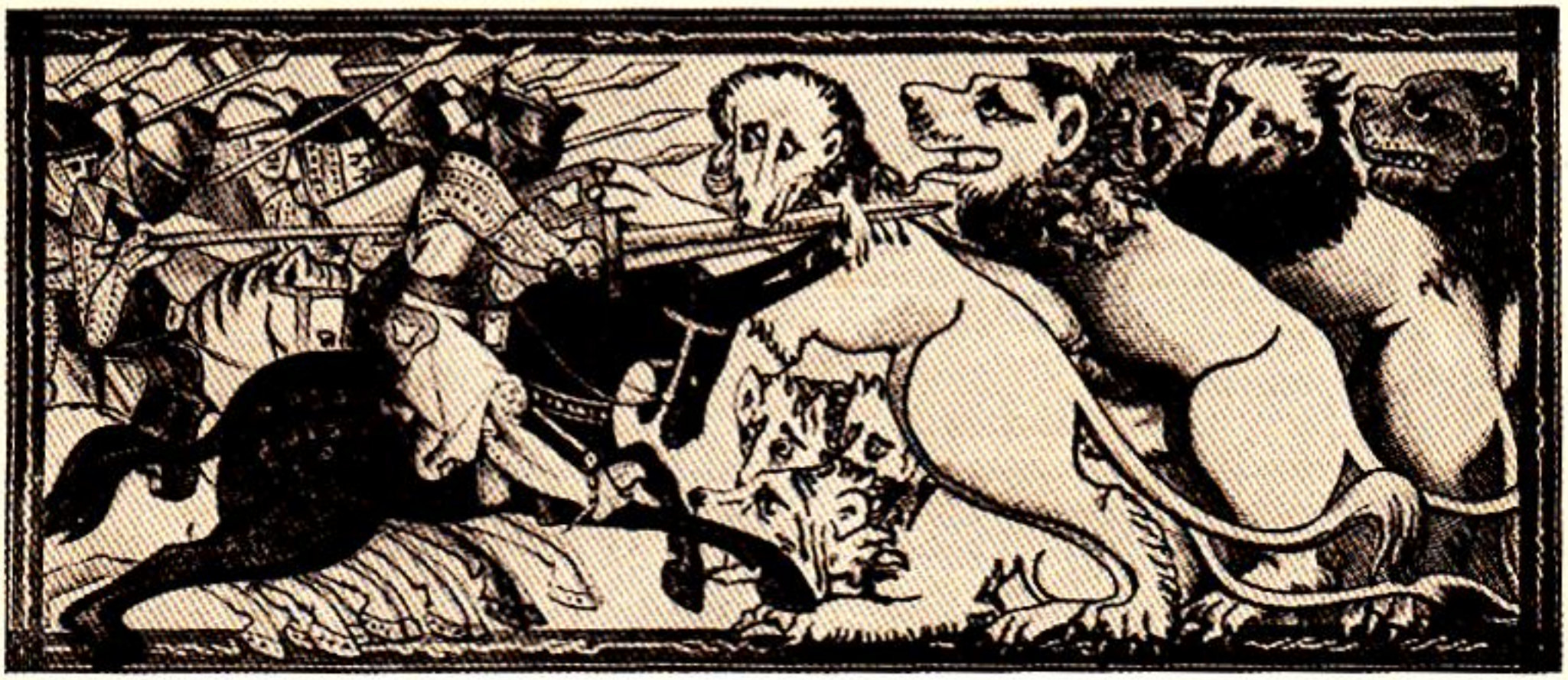
Aristotle was not merely a dedicated scholar himself, but he wanted to impart knowledge to others, to train more scholars. So he organised his famous Lyceum, which he directed for twelve years. But the Greeks failed to appreciate their great contemporary. In 323 B. C., when Alexander the Great died, an uprising occurred in Athens. As one who had been close to the late king, Aristotle was threatened with death. He had to flee Athens and died a year later.

Aristotle enjoyed such authority in the field of zoology that for two thousand years afterwards his views were

never questioned, and all subsequent zoologists ventured to do was add to, comment upon, and popularise these vews. One such eminent populariser of zoology was a rich and noble Roman who lived in the lst century A. D. (23-79). His name was Pliny the Elder (as distinct from his nephew, Pliny the Younger). He went down in history as the author of *Natural History*, a mammoth work, which consisted of 37 books. He also wrote on other subjects and penned *History of My Time* in 31 books, *History of the German Wars* in 20 books and a host of separate books on various topics. But he obviously valued his *Natural History* above all else. In the dedication to Emperor Titus, Pliny the Elder wrote: "The path which I am entering has not been trodden by anyone. Not one of us, not one of the Greeks has ever undertaken to give a single-handed description of Nature in its totality. Even should my design fail, the very urge to accomplish it was sweet and magnificent."

Pliny the Eder was not a scholar, but he held various high offices in the Empire, travelled extensively and saw a great deal, and whatever he saw, he described in his books. But mainly he relied on information contained in the works of other writers. The list of books he studied, which Pliny the Elder drew up himself, contained more than 2,000 treatises on astronomy, mineralogy, physics, botany, medicine, ethnography, engineering, anatomy, etc. In his *Natural History*, each of these sciences is assigned several volumes. Zoology occupies four.

While Aristotle sought to ascertain general laws governing the life of animals and used facts to support his theories, Pliny the Elder made no attempt to arrange the information in any kind of system and, even less so, to form any conclusions. He used hearsay and material borrowed from other works uncritically. As a result, his books contain, along with authentic information, a great deal of invention, cock-



Alexander the Great hunting lions. A miniature of the 13th century.

and-bull stories and even outright fables. For instance, Pliny the Elder wrote that embryos dropped from the sky. Unless devoured by wild beasts, they intermixed and turned into various animals, ordinary and fantastic ones. He wrote about birds with two hearts and giant ants, even asserting that bear's meat continued to grow after boiling. Pliny made no attempt to sift out the facts. On the contrary, he seemed to hanker after the fantastic and stuffed his works full of "miracles". He was an industrious worker and spent every free moment of his life either reading or dictating to scribes who followed him about everywhere. He read during meals and on the road. As soon as he had gathered enough facts, he set about dictating yet another book.

Quite possibly, he was similarly engaged while on board a Roman galley anchored in what is called the Bay of Naples today. On August 22, 79 A. D., upon learning about the appearance of strange clouds over Mount Vesuvius, Pliny ordered his galley to cross the bay and approach the shore. He wanted to take a closer look at the strange clouds. Just then, news reached the Romans about the volcano's eruption and the plight of Pompeii and Herculaneum. They weighed anchor, and the entire fleet went to the rescue of the populace of those two cities. Pliny observed the events occurring on shore from his vantage point on deck and dictated excitedly to the scribes, who barely managed to keep up with him.

Towards evening the eruption seemed to have subsided, and Pliny went ashore. During the night, Vesuvius exploded again. Huge clouds of ash, rivers of molten lava, a hail of huge boulders, and masses of poisonous gases descended on the city of Pompeii, burying thousands of its residents, including the eminent Roman patrician Pliny the Elder, who fell prey to his insatiable curiosity and did not live to see all his works published.

Their publication was completed by his nephew, Pliny the Younger, and for fifteen centuries afterwards these books lived on and were widely read. To be sure, there were a lot of inaccuracies, inventions and fantasies in them, but at the same time, they were the only "encyclopaedia" available — the only text-book students of nature had at their disposal. They preserved for us a multitude of interesting facts pertaining to Pliny's time, arousing in people a thirst for knowledge, and inducing them to observe and ponder.

So while mankind is greatly indebted to the great Athenian Aristotle, who was the first to undertake the study of zoology, the eminent Roman, Pliny the Elder, the first encyclopaedist and populariser, holds a place of honour in the history of science as well.

Two Millennia

A rabid mob was hurtling along the street. More people, armed with sticks and stones, were pouring in from by-streets.

This was taking place in Alexandria, a city founded by Alexander the Great as a centre of philosophy and science. The greatest scholars of antiquity, Archimedes and Ptolemy, Euclid and Aristarchus, had lived and worked here. The city had its famous Academy, with a dissecting room, observatory, zoological and botanical gardens.

But times had changed. And now an incensed mob armed with stones

and torches was headed for the temple of Serapis which was the repository of half of the 700,000 precious papyrus scrolls, many of them unique, of the world's largest library.

The roaring mob surrounded the temple and set fire to it. Sheaves of sparks were soon flying high into the sky, threatening the houses in the neighbourhood, while the fanatics, indifferent to their fate, watched with glee the destruction of invaluable works of the human mind.

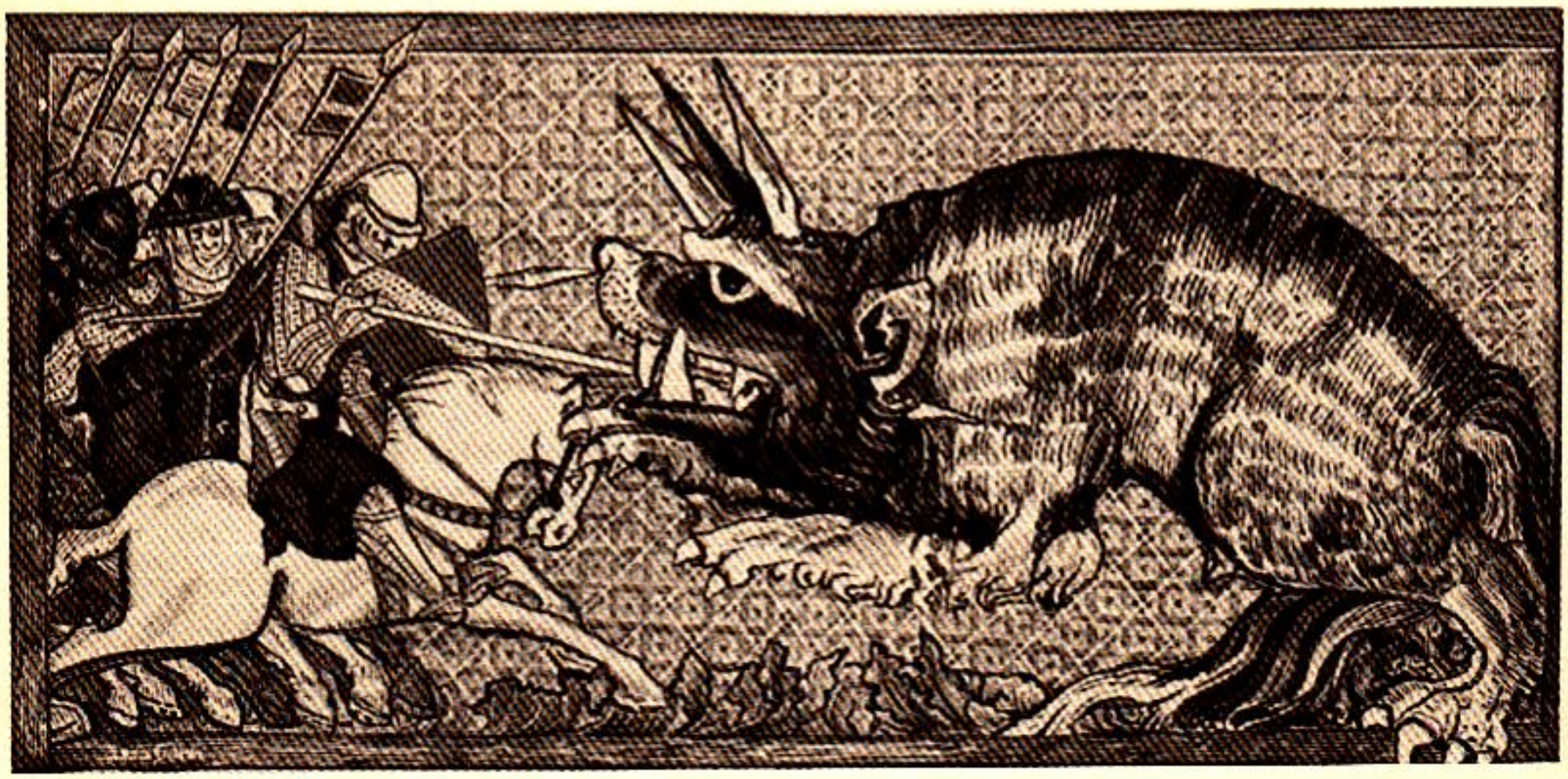
Theophilus the Bishop was pleased. It was he who had incited the mob to destroy the treasure-house of ancient wisdom. And now, he had received the report that the library had ceased to exist.

The Christian Church had launched an offensive against science, against knowledge, and against libraries. Anyone who could simply read and write fell under suspicion.

The church also came down heavily on animals which were worshipped by the ancients.

The Bishop Augustinus Sanctus declared: "Surely we are not going to be deterred by the fear of flames in which a few would perish from saving all from the eternal flames of Gehenna?" And that was a long time before the fires of the Inquisition blazed up all over Europe.

With the Inquisition came the burning of books, "witches", and "heretics", of all those who doubted the Church's dogmas, who thirsted for knowledge, who tried to discover the secrets of nature. The sciences of physics, chemistry, astronomy, philosophy were prohibited and ceased to develop; much of what had been learned



It was believed that Alexander the Great also fought monsters such as this one. A miniature of the 13th century.

was forgotten. In their stead came magic, alchemistry, astrology, and theology. The Christian God reigned supreme. He created the Earth and all things on it, and it was not permissable for sinful men to try and fathom His secrets, to question the Creator's omniscience.

Still, the clerics realised that people could be frightened into silence, but they could not be stopped from thinking, especially since they already had knowledge of the works of Aristotle and Pliny. Since there was no point in destroying these works, the church decided to adapt them to its dogmas, to use them as its own weapons.

So the clerics set about "editing" the scholarly works of antiquity. "If we find in them (in the works of ancient scholars) something of use, we shall commit it to our memory. And if we find something harmful, we shall scrape it off, cut it out with the sharpest of knives!" said one bishop. And scrape they did, cutting out huge chunks of knowledge.

Not content with crippling the works of ancient scholars, the theologians wrote a "history of animals" of their own. It appeared in the 2nd century A. D., under the title *Physiologus*, to be subsequently revised, and rewritten hundreds of times and translated into dozens of languages. The word "physiologos" occurs in Aristotle's works and denotes a person who studies nature and seeks to get at the essence of things and phenomena.

The theological *Physiologus*, for all that it adopted an Aristotelian title and included passages from his works, had nothing to do with the essence of phenomena. The church forbade all queries into the holy order of things. It had to be accepted unquestioningly, as God had created it. And the more miracles in the book, the better: in the first place, they would make for better reading, and in the second, they would strengthen the people's belief in the Almighty's omnipotence.

And so *Physiologus* informed its readers that the panther had a meal once in three days, then slept, and upon awakening, emitted such a pleasant scent that all animals were attracted to the beast, approaching it at their peril.

Young vipers, *Physiologus* asserted, ate the entrails of their mothers. Snakes drank water, but before drinking, emitted their poison into the spring. If attacked by a snake, one should undress quickly, for snakes feared naked men.

Geese, *Physiologus* harangued, were born on trees in Great Britain.

A hyena's shadow kept dogs from barking.

And so on and so forth.

But soon, even this parody of a book ceased to satisfy the clerics. People had to be constantly reminded of God, they reasoned. All reading should strengthen their faith. So *Physiologus* was subjected to yet another "editing". Now the information about the habits of the panther was concluded thus: "It was in this fashion that Jesus Christ was resurrected on the third day." In telling about the partridge, which was alleged to steal other birds' eggs, the author admonished: "In a like manner, the Devil steals other people's children."

While the editors (or, rather, authors) of *Physiologus* preferred to remain anonymous, quite a few books appeared whose authors did not conceal their names. One such author was the monk Vincent of Beauvais, who penned the book *Speculum Majus* (A Mirror of the World), which was in full accord with the canons of the Christian Church.

There was also Albertus Magnus titled by his contemporaries "doctor universalis, who was great in magic and greater still in philosophy and the greatest of all in theology". This "doctor universalis" was undoubtedly a gifted man and a brilliant lecturer. No auditorium at the Sorbonne could hold all those who flocked to his lectures. So he often delivered them in city squares. Naturally, both in his lectures and his writings, notably *De animalibus*, he proceeded from the divine origin of all things, and his books contained a goodly portion of miracles and fables. But alongside them, there were quite a few very sound propositions and correct observations. But the main merit of his activities consisted, paradoxically, not in his assertions, but in his negations.

He was among the very few who dared to express doubts as regarded all the "miracles" which inundated books describing new geographical discoveries. The Englishman John Mandeville, for instance, who spent 33 years in Asia and Africa after leaving his mother-country in 1327, upon his return to Europe wrote about one-legged people he had allegedly observed who were able to walk quite fast despite this handicap. He went on to assert that when going to sleep, they lifted this one leg into the air, and since the foot was very large, it protected them from the scorching rays of the sun like a parasol. He also told his countrymen about people who had such a huge upper lip that it also provided protection from the sun.

Still more fantastic information was contained in *Cosmographia*, the book written by the German Sebastian Münster and published in 1544. It told of dwarfs sustained by the smell of apples, of snakes protecting legitimate children and killing illegitimate ones. This book also featured people using their upper lip or their one leg as parasols, and ants guarding gold. And all these tales were believed, too! In the course of 200 years, Münster's book went through nearly 500 editions!

On the other hand, books that contained truth rather than invention did not enjoy any comparable success. Such was the case with the book written by the famous traveller Marco Polo, who visited Asia several decades prior to Mandeville.

In his book Marco Polo, too, included descriptions of headless people living in Siberia, a bird with iron feathers and the unicorn, a fabulous animal firmly believed in those days — for without these embellishments his book would have failed to interest readers altogether. But all in all, Marco Polo's book was essentially truthful, and truth was considered to be very dull.

So the church succeeded in stuffing the heads of literate people with all kinds of nonsensical "miracles".

But there was still Aristotle, whose prestige was so high that his assertion that common housefly had four legs was not disputed for many centuries. When someone counted a fly's legs and found there were six, he decided that it was a freak of nature, and that was the end of it. This high prestige, the clerics felt, had to be put to the service of the church. And so they used the name of Aristotle, carefully making selections from his works to suppress all free thought. For however great a scientist, his elevation to the rank of an infallible oracle can do nothing but harm to science.

Life continued, new discoveries were made, new observations registered, and new conclusions suggested themselves. And the new often contradicted

Sea animals as imagined by 15th-century zoologists.

Aristotle — especially the clerical interpretation of Aristotle. Yet the church came down heavily on anyone who dared to contradict the Great Aristotle, branding the culprit as a heretic. Aristotle was made into a kind of evil deity which suppressed all that was new and fresh.

The universities which were set up in some European countries in the llth and 12th centuries were dominated by the clerics as well, and the spirit of Aristotle was kept alive in them, allegedly symbolising scientific thought while, in fact smothering the true development of science.

Displayed at the Oxford University, the second most important university in Europe after the Sorbonne, was a list of punishments to be meted out for contradicting Aristotle.

To think that the great Greek, the founder of the science of zoology, should have been used by the church to impede the development of this science for more than two thousand years! For two thousand years zoology marked time, until Ulissus Aldrovandi dared to say out loud, although with much reservation: "Though it contradicts Aristotle, yet..."

However, before Aldrovandi there was Konrad Gesner!

Life and Death of Konrad Gesner

He was a physician and knew he was doomed. As a matter of fact, such an insight did not require any particular medical knowledge; the epidemic of plague which raged in Zürich and many other cities of Western Europe in 1565 was taking a dreadful toll of life; practically anyone who contracted it died, and its symptoms were known to all. Gesner knew that his very hours were numbered, so he asked to be taken to his study.

Attendants in robes of rough linen with tar-soaked masks covering their faces fulfilled his wish and left him alone in his study, closing the door behind them. A heavy odour hung in the room, but Gesner was used to it, as he was used to the mask and robe he had worn for the last few weeks. He had worn them as a knight wears armour. Gesner had challenged the plague, though fighting

illness was far from his everyday pursuits: he was a scholar and not a practising physician. However, his calling was to fight disease, and so he fought it. The robe and the mask had not helped — he became infected. He was doomed, and he wanted to spend his last dying hours in the study where he had worked so much. There he lay, fainting every so often, and in his delirium the room filled with various grotesque creatures. They flitted about the room, settled on the bookcases, tables and windowsills. Gesner knew them from descriptions. Those were sea monks! And that one in the corner was the sea devil, with a dog's head, goat's horns and fish's tail. "There they are!" Gesner cried. Or did he only imagine that he cried? Anyway, it did not matter.

This fearsome beast was described in detail by the French monk A. Tevet, the author of one of the first books on natural history of South America. Despite the fantastic portrayal of this animal, modern zoologists have identified it as a giant fossil (sloth).

An illustration from a book of travels, whose author purported to have seen such a creature "with his own eyes".

The important thing was that at last he was seeing sea monsters with his own eyes. He had wanted to see them so much all his life. When consciousness returned to the sick man, the monsters disappeared and recollections teemed in their stead.

So many people had come to this very room bringing the scholar all kinds of monsters —"dragons", "sea monks", "sea devils" and "basiliscs". Some of the monsters were expensive, others quite cheap. Gesner was prepared to pay all the money in the world for a real monster, but each and every time, they proved to be fakes, with parts of different animals more or less cleverly glued or sewn together. He sent the swindlers packing, yet he did not lose hope.

The thing is, Gesner actually believed in the existence of monsters, for he was a gullible man and was besieged by people who claimed they had seen them "with their own eyes". He kept hoping he would see these monsters one day, or if he did not, his descendants would, and they would give him his due for trying so hard to get to see and describe from his own knowledge a "sea monk" or a "sea devil".

His descendants, in fact, established that neither existed, but they forgave the scholar his naive gullibility, and they did give him his due for the titanic work he accomplished. For the first time after Aristotle and Pliny, a single man undertook to compile a "full zoological encyclopaedia", which included all the knowledge man had accumulated about animals in the intervening 2,000 years.

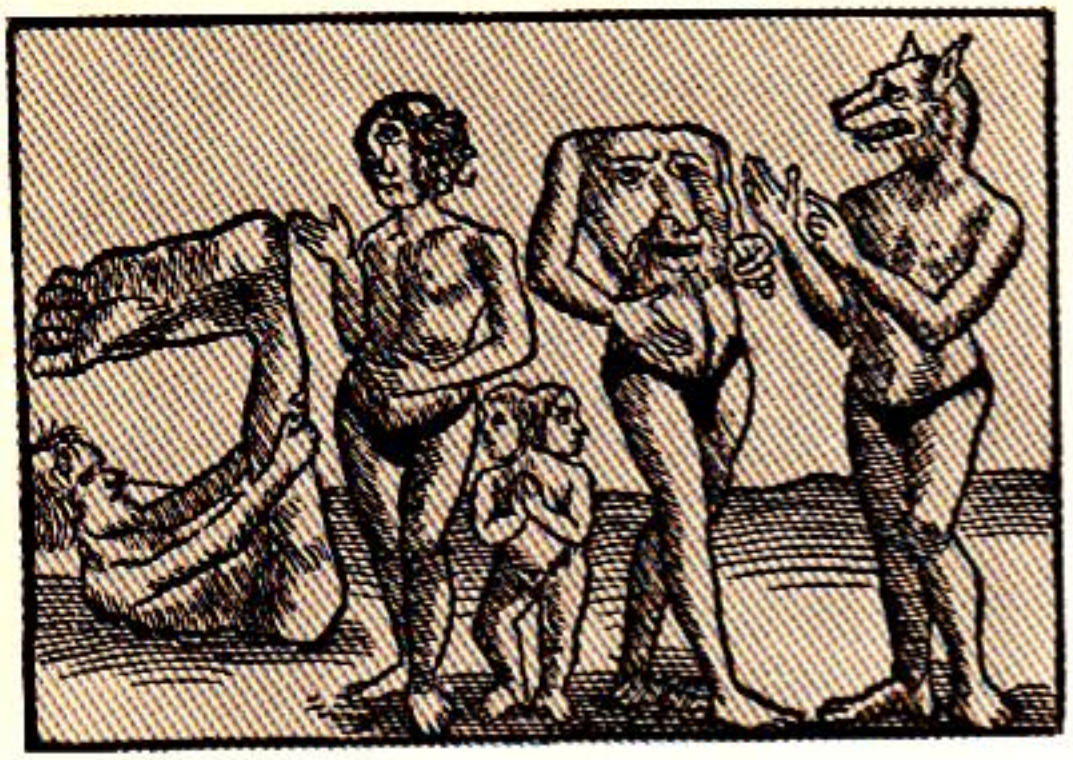
Gesner lived during the period which has come to be known as the Renaissance. It was a period of renewed interest in antique culture, art, literature and philosophy.

This was also a time of great geographical discoveries, the most important of which was the discovery of America.

It was the period when printing was invented — a great landmark in the history of culture.

And finally it was a time of church reforms. With Martin Luther, a widespread movement against the Roman Catholic Church, which became known as the Reformation, was initiated.

These were telling blows for the church, but it stood its ground. The Inquisition was still imprisoning and torturing all dissenters, people were still being burnt at the stake. The clerics persecuted Copernicus, burnt at the stake Giordano Bruno, and threatened Ulisses Aldrovandi with the same fate. Hundreds of thinkers and scholars were imprisoned or executed for various heresies. But



Another traveller, Münster, published a book in 1550 where he described people such as these whom he had also seen "with his own eyes".

the march of science could no longer be stayed.

Many wonderful discoveries were made in the 14th-16th centuries, and a galaxy of brilliant scholars came to the fore during the Renaissance. Zoology, though, was less fortunate than other sciences. But still, the history of natural sciences can boast of the accomplishments of several scientists who lived in the 16th century; the Frenchman Guillaume Rondelet, and the Italian Hippolyte Salviani, who studied fishes, the Frenchman Pierre Belon, who studied birds, and the Englishman Thomas Moufet, who made a study of insects.

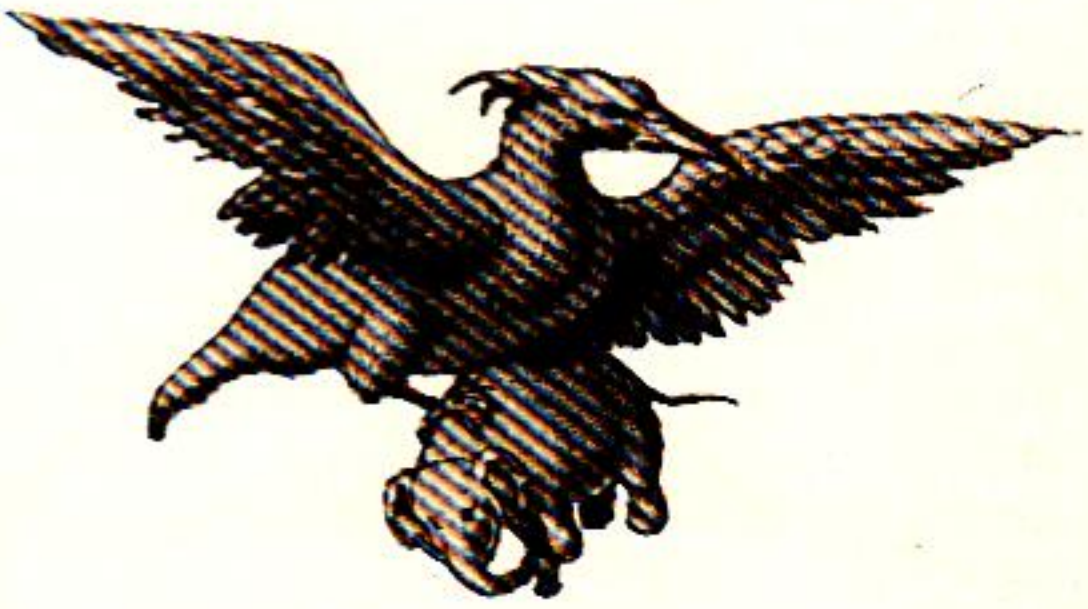
Ulisses Aldrovandi also lived during the Renaissance. A man of rare dedication, he denied himself the basic necessities to buy samples for his botanical and zoological collections; he established botanical gardens in Bologna and left behind a multi-volume description of animals.

The ignorant townsfolk were puzzled by his occupations, while the clerics were incensed by his devotion to science and his wide knowledge. They set a mob of tramps on his house, who ransacked it. This did not deter the scholar from his scientific pursuits. Then it was decided to burn him at the stake, a fate the scholar escaped by pure chance.

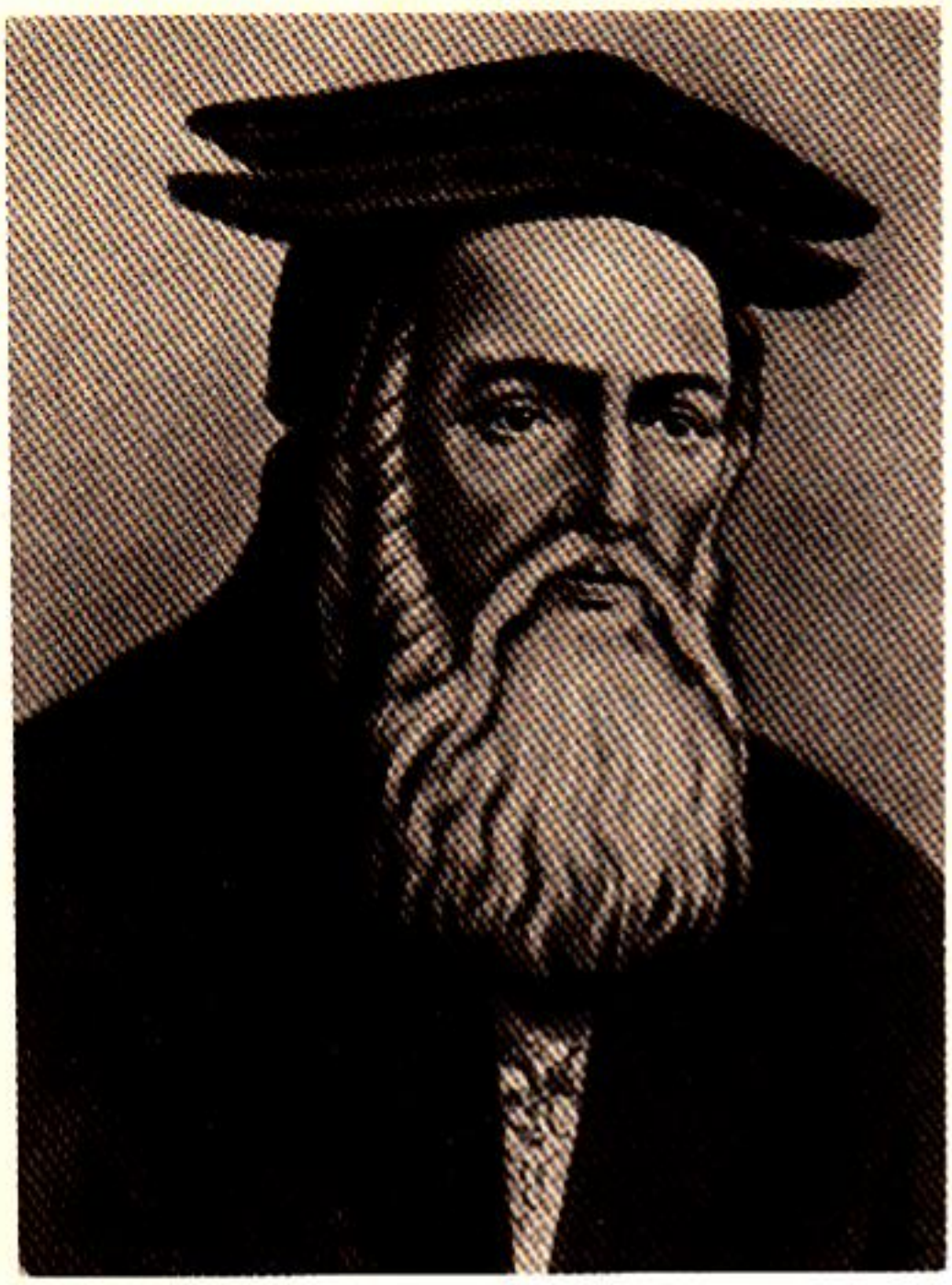
Still, none of the naturalists of the Renaissance did so much for zoology as Gesner.

It was not at once that he found his calling, which was to earn him everlasting glory and gratitude of the following generations.

Konrad Gesner lost his parents at an early age and was brought up by his uncle, a poor artisan who barely knew his letters. In all probability Konrad would have followed in his footsteps had he not possessed an overpowering thirst for knowledge. We do not know who helped him receive a higher education, but we know that a young professor of Greek Konrad Gesner, began to teach at the University of Lausanne in 1537. He was then twenty-one. It would seem that he had accomplished a lot, but Greek grammar did not really in-



The legendary bird Rukh.



Konrad Gesner (1516-1565).

terest him. Four years later, this professor of Greek became a physician and a naturalist.

At twenty-five, people usually feel young and carefree. Not so Gesner. He looked much older than his years and was in poor health, the result of overwork and undernourishment during those years when he had to earn his living while studying. Despite his frailty, Gesner would not stay put: a naturalist, he reasoned, had to see with his own eyes the plants and animals of other countries.

Gesner visited many European countries, and everywhere he collected plants, for botany was his first love among the natural sciences. He brought numerous herbaria to his native city of Zürich, and then laid out botanical gardens, which he maintained at his own expense, and which soon became the pride of the city.

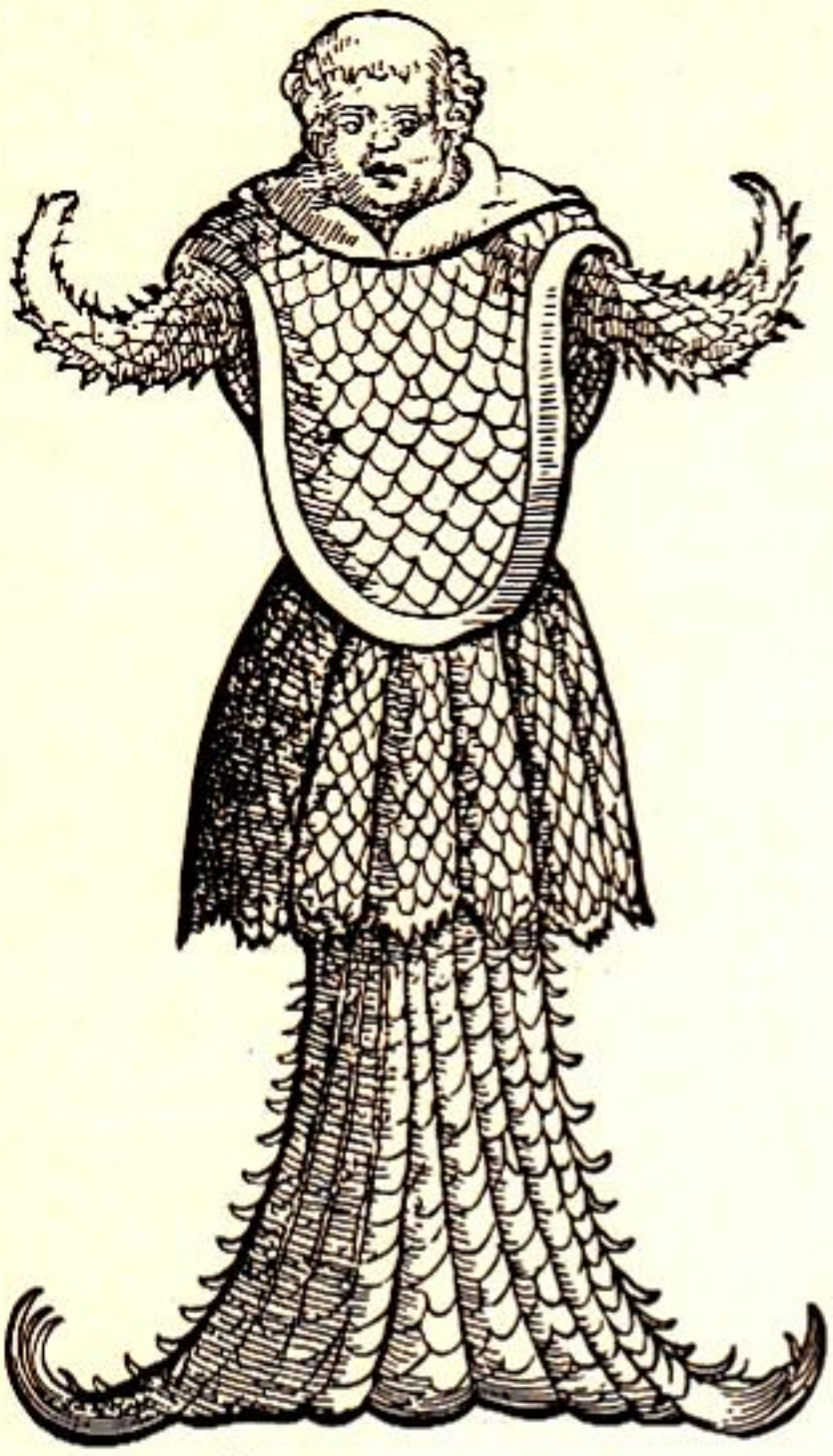
As a botanist, Gesner studied plants and sought a principle that would enable him to classify them; as a physician, he was concerned with their medicinal properties. Gesner published several books on botany, but kept in touch with his first vocation and wrote books on linguistics as well. Then he became interested in minerals and wrote a book on mineralogy. Still, he owes his fame to his contribution to zoology.

Obviously Gesner was aware of it, and that was why he wanted to spend the last hours of his life in his study, which was really a zoological museum.

The sick man was no longer able to see the exhibits in his museum even when he regained consciousness, for he lacked the strength to open his eyes. But he did not really need to open his eyes to see the contents of his study — he knew by heart every object there down to the minutest detail. Stuffed beasts and birds peered at him from glassed shelves and special stands. There were herbaria, skeletons of animals, and collections of insects. But his most cherished possession were four large books of *Historia animalium* (each as big as a modern-day newspaper) and heaps of sheets covered with writing — his notes for the fifth, and last volume, which was to deal with insects.

Gesner was not destined to see his fifth volume in print — it would be published by his friends and disciples after his death.

The four volumes he did publish in his lifetime contained all that people



The "sea monk". (From Gesner's book.)

knew about the animal kingdom. Gesner had studied all available sources, beginning with Aristotle and Pliny and ending with works of his contemporaries. He was proficient in German, French, English, Italian, and Greek, knew Latin and Ancient Greek, as well as several oriental languages. So he was able to read most of the books in the original. He performed a truly titanic labour of selecting all that concerned animals from hundreds of books.

He was a man of conscience and an honest scholar, and he always cited the relevant author. Appended to each volume was a list of works that had been used.

While quoting some authors, he often made the reservation that he did not have full faith in the facts described. The same applied to pictures — and there were over a thousand of them in his *Historia*. He would sometimes attach the following caption to a picture: "This drawing was made by the artist, and I have no means of verifying its accuracy."

All the same, Gesner was excessively gullible. He included in his books, beside his own accurate records and trustworthy accounts of other people, descriptions of "sea monks" and other monsters provided by people who had allegedly seen all those miracles "with their own eyes". Well, after all Gesner was the son of his age, but in compiling an encyclopaedia of animals, he far outstripped his time.

Modern books on zoology, except for dictionaries or some special reference books, do not list animals in alphabetical order, for this would place side by side such animals as cat, cockroach and cuckoo. Mammals, birds and insects would be all jumbled together.

Today there is a well-defined system of classifying animals by classes, families, genera and species, with the signs of each class and genus clearly defined.

But what was Gesner to do when no system was available and confusion reigned supreme? Apparently he had neither the time nor the inclination to sort out the confusion or invent a system of his own. So he adopted the alphabetical order for his list of animals. However, this did not make his books dictionaries or reference books, for each book, and even each entry, had a system of its own. First, Gesner gave the name of the animal in various lan-

guages. Then followed a description of the animal, its habitat and way of life. The next paragraph was a utilitarian one and told about hunting the animal, training it, the use made of its meat, hide, etc. In conclusion Gesner explained the origins of the animal's name, its place in religion, and cited sayings, proverbs, fables and legends about it.

No such work had ever been compiled before him. Gesner knew this and hoped that mankind would appreciate his mammoth labour. And so it did. For two and a half centuries, nature lovers pored over *Historia animalium* and students of nature studied it.

Naturally, the following generations made progress, but it was Gesner who laid the foundations for their advance.

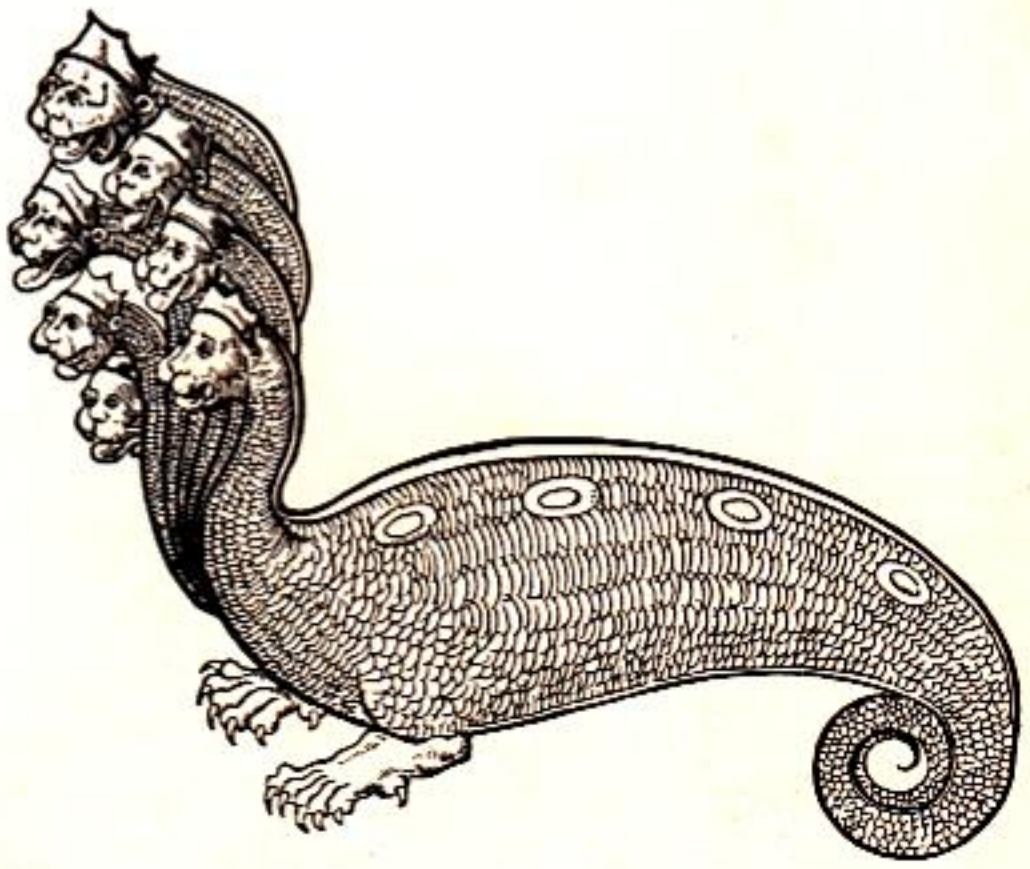
The information contained in Gesner's encyclopaedia was used by zoologists for a long time after his death.

Carl Linnaeus' *System of Nature*

That day went down into the family chronicle of the Linnaeuses as the day of the newlyweds' first quarrel. Sara-Liza alternated between anger and amusement, while Carl was indignant — although Sara-Liza had more cause for vexation. She had been arranging the things in their new flat and making it a cosy place to live in, filling the cupboard and chest of drawers with bed linen and underclothes, placing the crockery on the shelves — and what had her husband gone and done? He had rearranged everything, with the result that it was well nigh impossible to find anything. Tea and dinner services had been stood in such a manner as to make it impossible to lay hands on the needed cup or plate at once, and the linen was in complete disorder.

"Why have you done it?" Sara-Liza wailed. "Why did you put your shirts and my chemises in one pile, and why did you separate the sheets from the pillow-cases?"

"Because there must be a system in all things," Carl argued heatedly. "Why should shirts lie in different drawers merely because they are a man's or a woman's? Sex is not a definitive sign. All shirts belong to one order of things. It's another thing if they are worn during the day or at night, if they are plain or fancy. That makes them different. As for sheets and pillow-cases, of course both are bed linen. But you cannot class them together on the strength of this sign alone. Sheets are..." But Sara-Liza had no time to listen to all those crazy explanations, and she set about

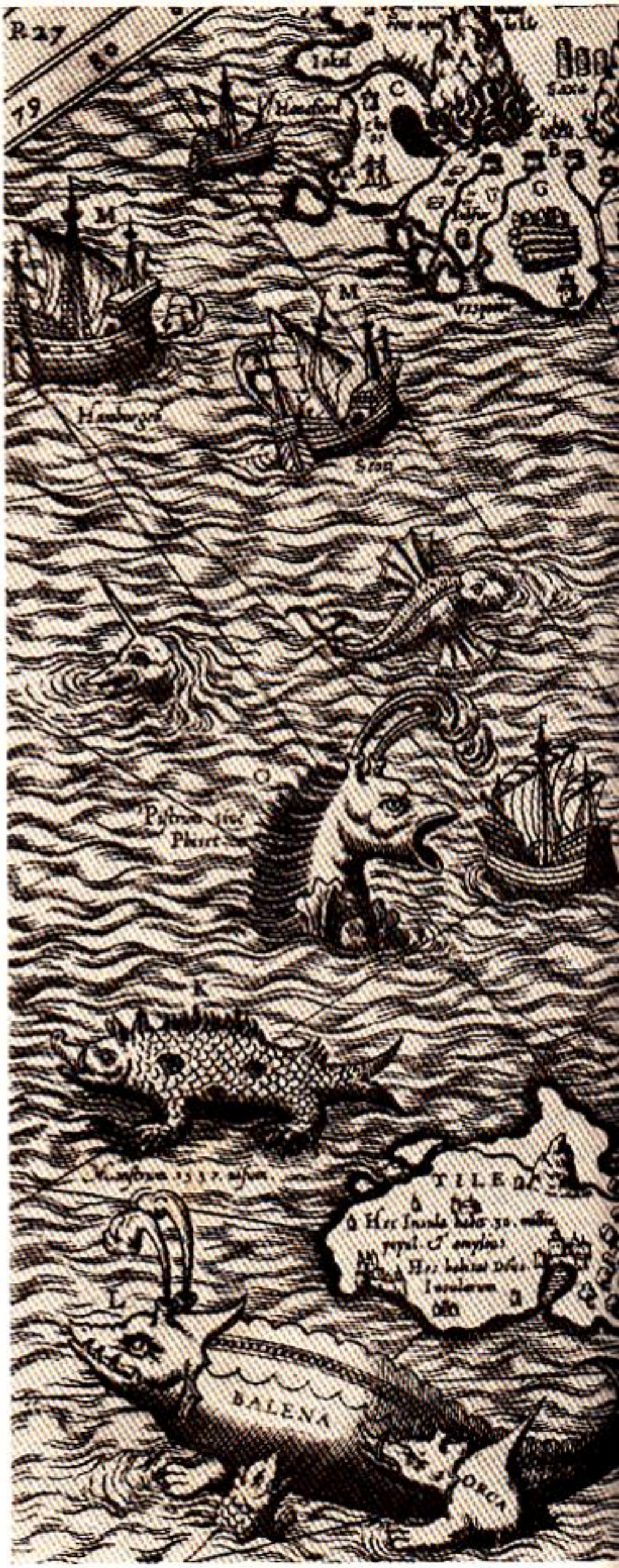


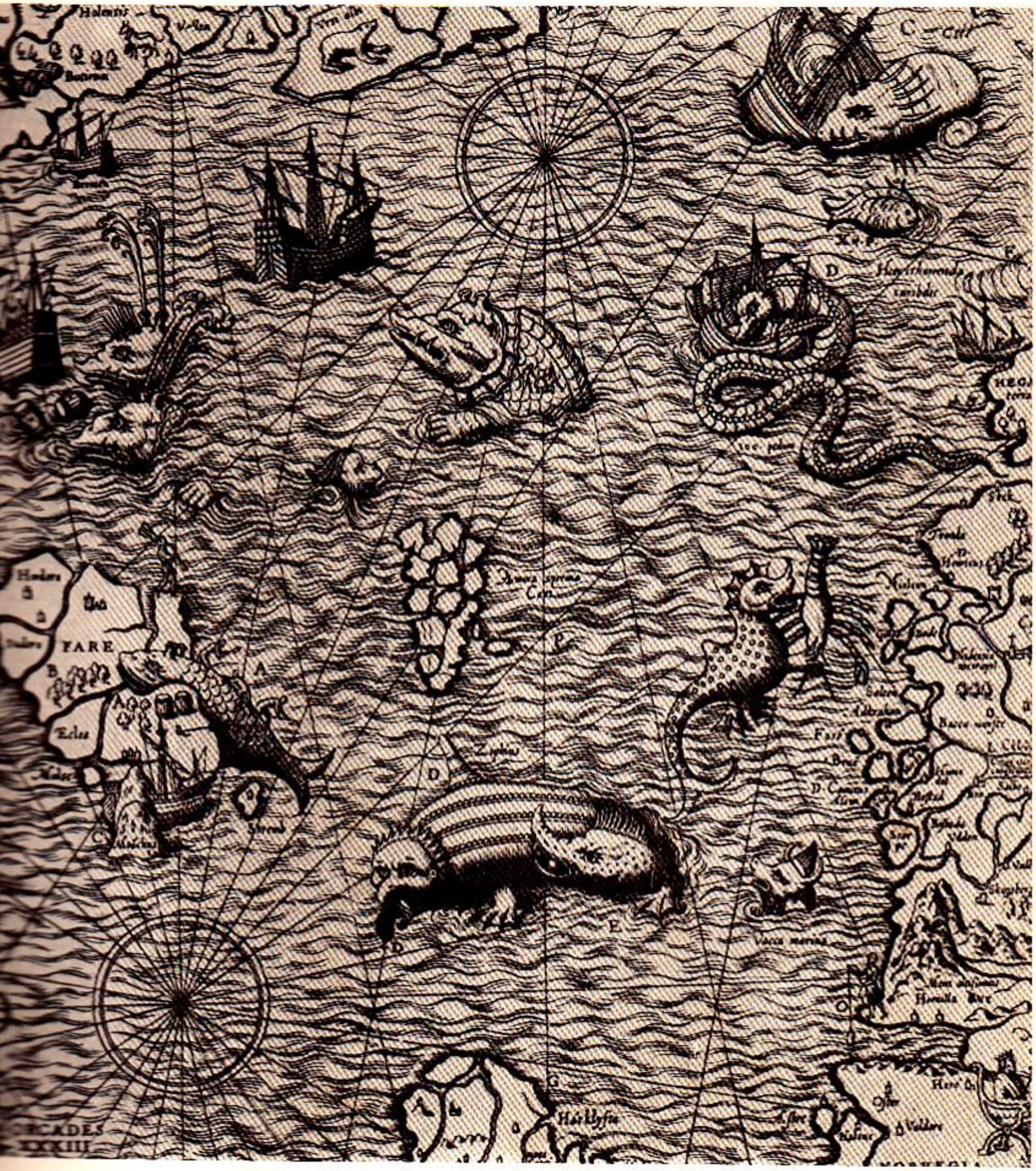
"Hydra Monstrosa" — the seven-headed hydra which was demonstrated to the public in Venice in 1530. (From Gesner's book.)

restoring order the way she saw it. Much as Carl fumed at this "chaos", he had to give in to his young bride — he had not spent five years waiting to marry her to quarrel over where the bed linen would go.

The year 1735 had begun unpropitiously for Carl Linnaeus. As a matter of fact, he had never been particularly lucky. But this year was worse than the others. The pupil he had been tutoring, previously extraordinarily dumb, suddenly began receiving good marks at school, and Carl lost his only source of income. The pupil's father very reasonably decided there was no cause to pay good money to a tutor if his son could now manage by himself. Nor did the poor folk come to him for medical help that year. They used to consult him, a former student of medicine, not being able to afford a proper doctor, but that year the poor people were, for some reason, hale and hearty, and the well-to-do ones used the services of the doctor Moraeus. Not that Linnaeus envied Moraeus or had any grudge against him. It was all as it should be — Moraeus was a diplomaed physician and an old-timer in the town, so, naturally, the patients had confidence in him. Still, it was on account of Moraeus that in the year 1735 Carl Linnaeus was robbed of his sleep and peace of mind. It all came about as the result of his meeting Moraeus's daughter Sara-Liza.

Carl was a man of action, and when he realised he was deeply in love with Sara-Liza he made her a formal proposal. The girl, for her part, had become attached to the sturdy and impulsive young man with a high forehead and burning eyes. So she agreed to marry him. But her father Moraeus had a few objections. Not that he did not like Linnaeus, but... Carl was already twenty-

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eight, and at that age, one was expected to be able to offer his bride a position in society. But what was Carl? A student who had not finished his course, and a hot-headed man to boot, who was known to have used his fists to resolve an argument. Rumour had it that it was on account of a fight with a lecturer that he had been expelled from the university.

In a word, Carl's social standing and reputation were not the most enviable. Still, doctor Moraeus must have been astute enough to appreciate his worth, for he did not forbid the marriage outright but put forward certain conditions: the wedding would only take place after Carl had obtained a scholarly degree and a well-paid job.

Well, Linnaeus agreed to these conditions. What were a few more difficulties to him?

His father Nils Linné, a village curate, had dreamed of a clerical career for his son. But the boy was fascinated with plants from early childhood. He was a less than mediocre pupil at school, and his father, angered beyond measure, decided to have him trained for some manual trade (if the lazybones was not fitted to be a parson, let him be a cobbler. It was as good a way of earning one's livelihood as any). And that might very well have been Carl's lot, if not for the local doctor Johan Rothman. Although this man made no spectacular contribution to medicine, biology owes him a lot for saving Linnaeus for science. Not only did he talk Carl's parents out of their intention of making him a cobbler's apprentice, not only did he advise them to send him to a medical school (in those days it was widely believed that an interest in plants was a qualification for a medical career), but he also managed to overpower Carl's abhorrence for Latin. Rothman, who was a clever man, went after his goal in a roundabout way. Complaining of lack of time, he asked Carl to translate a passage from Pliny for him. Carl was loth to refuse his benefactor and so sat down to do the translation, much as he hated the task. And once he got immersed in Pliny, wild horses could not drag him away. Rothman's ruse worked perfectly. Carl all but learnt Pliny's writings by heart, mastering Latin in the process.

Thus Carl graduated from secondary school and entered the medical department of the University of Lund.

Carl's dedication to science, made such an impression on Professor Stobaeus that he undertook to help the young man along financially, and so Carl was able to get by in Lund, even though his father could not afford to give him an allowance.

Yet it was his very devotion to science that was a source of trouble to him on many occasions.

Carl could have finished the course at Lund, but he was dissatisfied with lectures of the university professors and the library was not big enough for him. He would not be content with receiving a doctor's diploma without really mastering all the available knowledge in biology. So he left Lund University and his patron Professor Stobaeus and moved to Upsala University where there were many outstanding scholars on the staff. The university had a rich library and even botanical gardens.

"Upsala" in translation means "a tall hall". According to legend, ancient pagan gods used to hold council here, on the site of the city. To Carl this lofty name suggested huge auditoriums with tall ceilings. So he left Lund Uni-

versity, which gave him an excellent character, describing him as a gifted and well-informed student "whose conduct and industriousness had won him the affection of all those who knew him", and came to Upsala.

He was in for a disappointment though. The famous scholars had nearly all stopped lecturing at the university, and several university buildings had burned down during a fire twenty-five years before, together with the collections and herbaria Linnaeus had been dreaming about. Besides, here in Upsala Carl came to know real need: the "royal grant" was so miserly that it would not feed a student for a week. Even then, reduced to his last coin and faced with the choice of buying a loaf of bread or a candle, Carl invariably voted for the candle: he could skip a meal after all, but he could not give up his reading. But all too often, he did not have money for a candle either. Then he would go outside and read by the light of a street lamp.

His clothes were so worn that he looked like a beggar rather than a student. His shoes had no soles left, and he had to put pieces of birch bark underneath.

A year passed in this manner. Letters from home informed him that his father was ill, and he begged Carl to come back and take his place: he had enough education for the position of curate, and the church was left without one. So Carl decided to go home. Again only a lucky chance preserved him for science. One autumn day in 1729, he went to the botanical gardens for a farewell visit. In the gardens he met a theologian who was engaged in writing a book about plants mentioned in the Bible. For this important work he needed an assistant well versed in botany. Carl seemed cut out for the job and, now that he was assured of means of subsistence, he decided to stay on at the university.

A year later, while still a student, he was given a job as a lecturer in botany at the university, and in 1732, he went on his first exploration trip — to Lapland.

Natural sciences in those years were not held in high regard at the university. Physicists, physicians, botanists and the like were considered an inferior brand of scholars. The leading sciences were theology and philology. Still, Carl was issued a small sum to cover the expenses of his journey.

This was not done out of love for natural sciences or Linnaeus himself. The king had simply inquired whether the collection of Lapp animals and plants, which had been destroyed in the fire of 1702, had been restored yet. So the university authorities had to cough up the money. To be sure, the sum was so niggardly that Carl had to cover hundreds of miles on foot, sleep in haylofts and eat so sparingly as to barely keep body and soul together. And still, he was left without a penny towards the end of his trip. Yet his main objective had been accomplished — he brought back a great number of drawings, notes, and materials for a herbarium, though one cannot be expected to carry a great deal while travelling on foot.

It was at that time that Linnaeus began his lifelong work of systematising plants "in good order"— a task he only completed twenty years later. He might have coped with the task sooner if not for an unpleasantness that transpired at the university. His enemies, especially a certain lecturer named Rosen, resented the "upstart" who had no academic degree. They would not admit that even

then Linnaeus was among the most knowledgeable botanists. According to university rules, a person who held no academic degree had no right to lecture at the university, so Linnaeus' enemies had him dismissed. It was then that Linnaeus had it out with Rosen. The matter did not go as far as fisticuffs, but obviously no words were minced. Rosen made the most of it, telling all and sundry that Linnaeus almost killed him.

Linnaeus was forced to leave Upsala. Some time later, he found himself in the town of Falhun.

His intention was to go abroad at the first opportunity (in Sweden at that time, only academic degrees granted abroad were rated highly), and he set about saving money for the trip. His proposal to Sara-Liza and her father's conditions speeded up his departure. He had no doubt at all that he could obtain an academic degree. He was used to overcoming difficulties impelled by his love for science. And now he also had his love for Sara-Liza to urge him on!

Carl intended to stay abroad for only a few months, but things worked out differently. He obtained his medical degree soon enough. But, in addition to his medical thesis, he also took along his paper in botany — which contained only 13 pages (although each page was the size of present-day sheet of newsprint). The work was entitled *Systema Naturae (A System of Nature)* and presented a draft of an all-embracing system he would work on for many years to come, continually enlarging and perfecting it, until, in its last lifetime edition (the 12th), it would take up four volumes consisting of 1,335 pages.

But even this small booklet of 13 pages made quite an impression on specialists. Many leading scholars were enthusiastic about the system proposed by the young botanist. Of course, it also found rabid opponents. But that was only another proof of its worth — nobody would bother to attack an insignificant work so furiously.

Before long, Linnaeus's name became well known among botanists. His reputation, to be sure, did not make him rich, but it opened for him the doors to the largest private collections, and this for Carl was more important than money.

The owners of such collections usually had but little knowledge of plants, and they would ask Linnaeus to help them sort them out. So Linnaeus would put the collections in order, classifying and describing the plants.

Every year brought Carl Linnaeus greater recognition and added to his publications. He became a recognised authority and was elected to the Paris Academy. But it was high time he went back to Sweden — Sara-Liza had been waiting for him five years.

His fiancée was happy to see him and admired the pack of diplomas and books bearing his name. But the happiness was short-lived. Knowledge, fame, diplomas and books were still not enough. To be able to marry, they had to have money to live on. And money was the one thing Carl Linnaeus was always short of.

Once again, chance came to their rescue. Carl managed to cure a patient who seemed beyond hope and had been pronounced incurable by all the doctors he had seen. Whether it was really Linnaeus who helped him or whether the disease changed its course, Linnaeus never knew. But he won a reputation as a miracle-working doctor, and patients flocked to him.

He was soon making a good living and then received a job at the Admiralty.

Before long, the now famous doctor Linnaeus was invited to attend the king himself.

He had more patients than he could cope with, and the money was pouring in, but Carl Linnaeus no longer had any time for his beloved botany. On the other hand, doctor Moraeus now withdrew his final objection, and Sara-Liza at last became Carl's wife.

Shortly after the wedding day, the quarrel I described at the beginning of the chapter occurred between the newlyweds. A minor occurrence in itself, it had far-reaching consequences for Carl Linnaeus and probably for science as such.

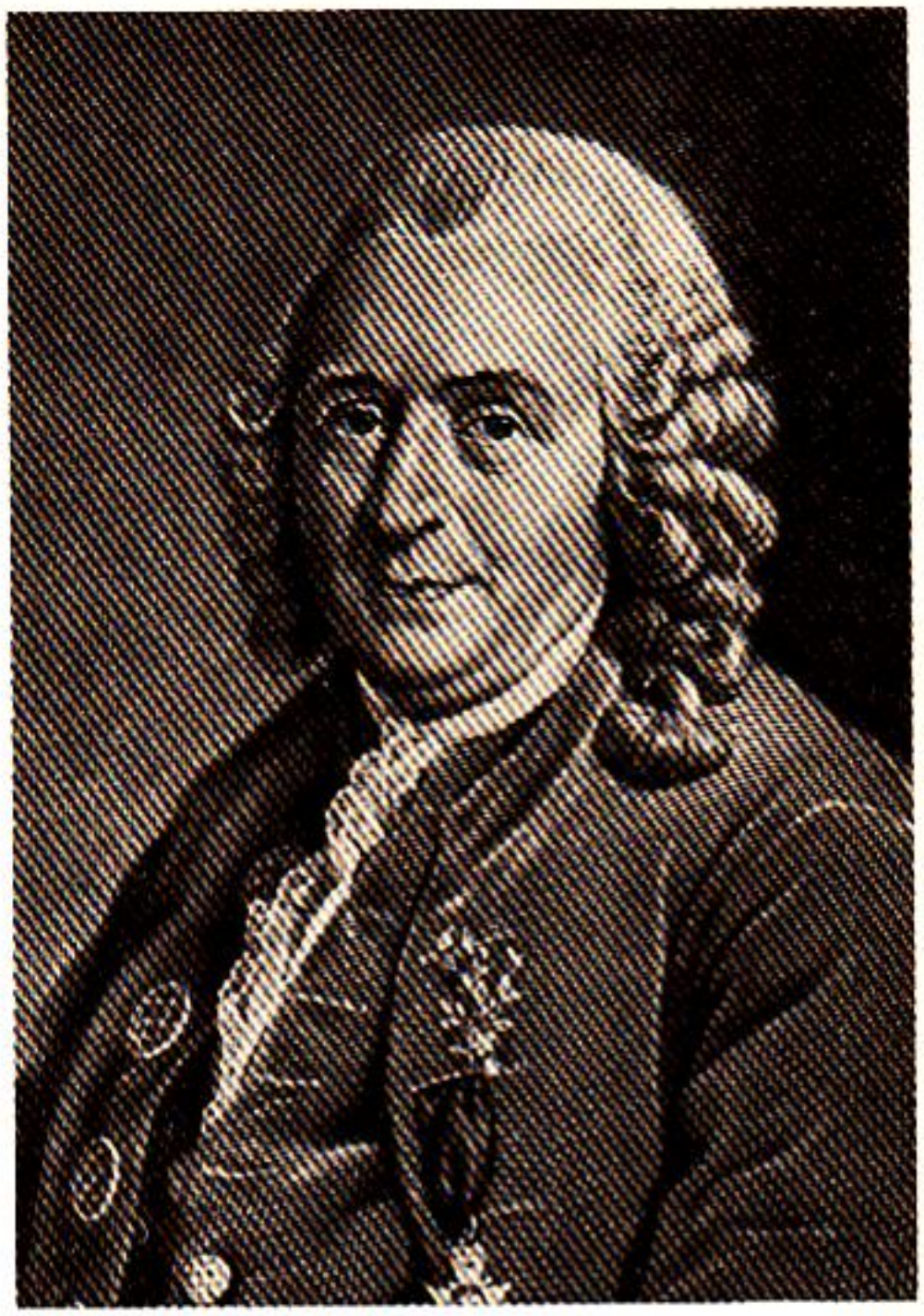
In the months which preceded his wedding, Linnaeus all but abandoned his scientific pursuits and spent all his time attending rich patients. And now the quarrel about the arrangement of the crockery and the linen reminded him that his heart lay, first and foremost, in systematisation.

Soon Linnaeus returned to the University of Upsala, where he continued lecturing for the next thirty-seven years, till the end of his life.

He delivered lectures and laid out botanical gardens anew. He conducted seminars and replenished the collections. Yet the main work of those years, as of his entire life, was work on his system of classification.

By inclination and by his principal works Linnaeus was a botanist. While still a young man trying to win Sara-Liza, he earned himself the title of the Prince of Botany. His principal books are about plants, and his principal job was that of professor of botany. Still, zoology owes a lot to Linnaeus, for his system embraced animals as well.

While "introducing order" into the plant kingdom, Linnaeus could not



Carl Linnaeus (1707-1778).

The medal commemorating Linnaeus.

simply overlook the animal kingdom. And since he disagreed with all the previous systems in zoology, or, rather, all attempts to systematise animals, he suggested a method of classification all his own.

He divided the entire animal world into six classes.

The first class included animals with a four-chamber heart, warm red blood, who gave birth to live cubs, and reared them with their own milk. The body of such animals is usually covered with hair. In the earlier editions of his system, Linnaeus called them quadrupeds. In later, improved ones, mammals.

The second class included animals with the same characteristics but who laid eggs and were covered with feathers instead of hair, that is, birds.

In the third class, Linnaeus included both amphibians and reptiles which were cold-blooded and breathed with lungs.

The fourth class included fishes. They had cold blood, too, and breathed with gills.

The fifth class included insects, characterised by "white" blood (blood fluid), absence of an atrium in the heart, and segmented legs.

And, finally, the sixth class included worms, distinguished from insects in that their tentacles are not segmented.

Altogether Linnaeus described nearly 4,200 animals, of them 1,222 species of vertebrates (mammals, birds, fishes, reptiles and amphibians), 400 species of invertebrates (excepting insects) and 1,936 species of insects, to which he also assigned the crustaceans, spiders and myriapods. Into the class of worms he placed all those animals which did not fit into the class of insects.

Linnaeus ignored microbes altogether. He did not like working with a microscope, though by that time microzoology had scored considerable successes. Linnaeus ignored the microorganisms, arguing that God had made them invisible to man and thus meant for His own use exclusively, so men had no need to bother about them.

On the whole, Linnaeus was a firm believer. He asserted that there were just as many species now as were created in the beginning by the Infinite Being.

A page from the ABC book which was written in 1694 by Karion Istomin for Prince Alexei, the son of Peter the Great.

One cannot reprove Linnaeus for this, however. Nor can one blame him for proceeding from purely external features in describing and classifying animals, rather than from their internal structure and manner of life or for making other mistakes which are obvious to us. He was a son of his age, and a genius of his age, let us add. He far outstripped his time, for all that he could not break free of its hold.

One may argue that he described only 4,200 species of animals, while today we know over a million, Linnaeus's six classes have today grown to 23, and his system of classification has been expanded, added to, and modified hundreds of times since. New additions and clarifications are continually being made. But Linnaeus's greatest achievement was that he put an end to chaos and confusion in the study of animals and plants — through his system as such and by giving each species a double Latin name.

His binomial system was not the first ever. Others had tried to introduce it before him, but nobody succeeded. Linnaeus insisted that the name of every animal and plant should consist of two words, one (a noun) denoting the name of the genus, the other (an adjective) giving the name of the species. Let us say we want to name the thrush. Formerly, the word "thrush" was used to denote the song thrush, the missel thrush, the black-bird and any other kind of thrush known, all jumbled together. Linnaeus, now, had to have order in the thrush family as well. There is no plain thrush, *Turdus*, in general, but there are definite species. And here the binomial system comes to our aid. We have the various species denominated as *Turdus viscivorus* (the missel thrush), *Turdus pilaris* (the ashberry

"The chameleon beast". An old Russian folk print.

thrush), *Turdus merula* (the black-bird), and *Turdus philomelos* (the song thrush). The same applies, say, to bears. There is no plain old bear (*Ursus*), but *Ursus maritimus* (the polar bear), *Ursus arctos* (the brown bear), *Ursus horribilis* (the grizzly bear), and so on.

Today we cannot imagine how people managed to get their bearings in the animal world without the binomial system. After all, many animals within one genus have striking differences both externally and in their ways of life. Zoology was a muddle of names, and zoologists often failed to understand each other because they did not know what animal was being referred to. Finally, they simply could not take stock of all the animals.

Of course the Linnaeus system had many faults. But the advantages it offered were immeasurably greater. From then on, thanks to Linnaeus and

his binomial system, the study of animals progressed at an incomparably faster rate.

The Theory of the Great but Unlucky Man

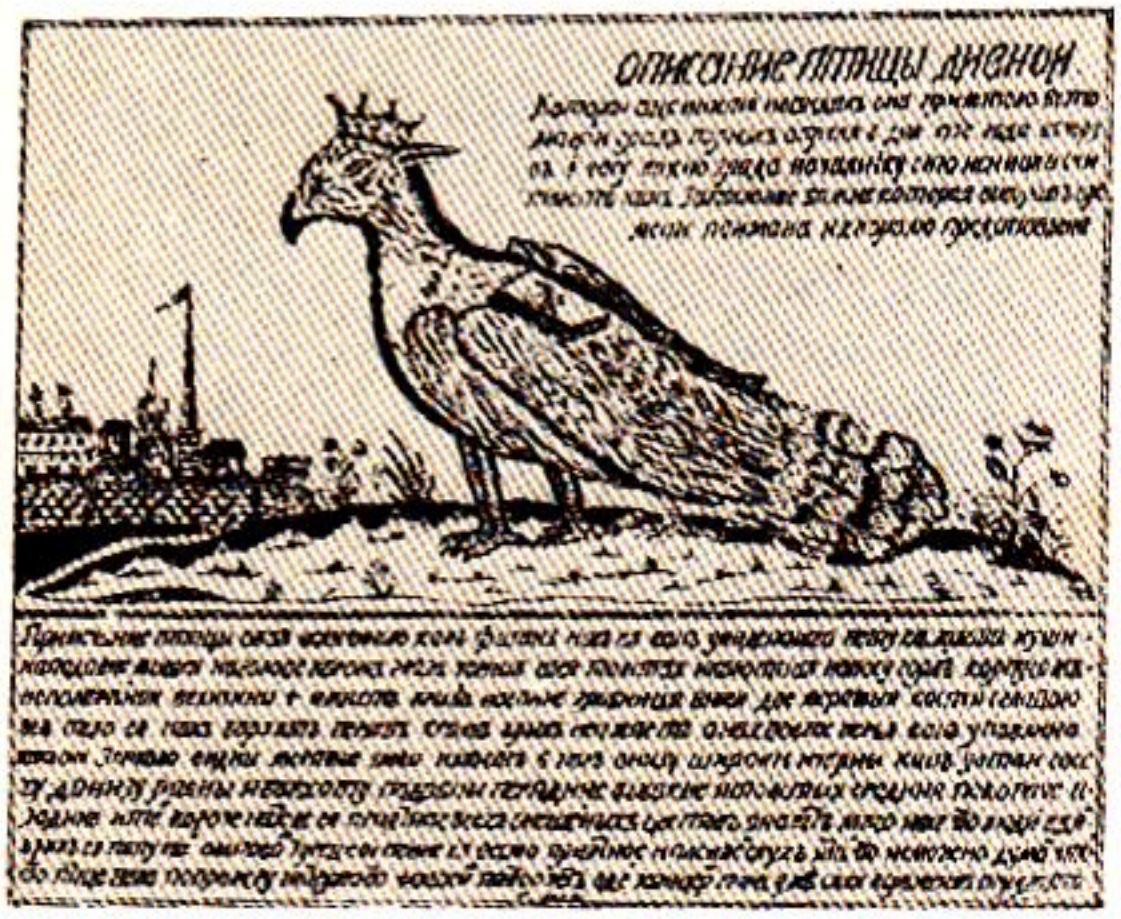
He has gone down in the history of science as Lamarck, but his whole name was Jean Baptiste Pierre Antoine de Monet de Lamarck. In olden times, people believed the longer the name given the child, the luckier the man would be. Alas, his long name did not bring Lamarck much luck. He was unlucky during his lifetime, and he was unlucky after death: even the grave of this great scientist was lost, and many decades passed before people appreciated the great contribution he had made to science.

Yes, he was born under an unlucky star, and failure haunted him from childhood. He dreamed of a military career, but was sent to a Jesuit college. He ran away from that school and finally did become an officer, but only to be forced into an early retirement by his fellow-officers who resented his refusal to share their pastimes of carousing and playing cards.

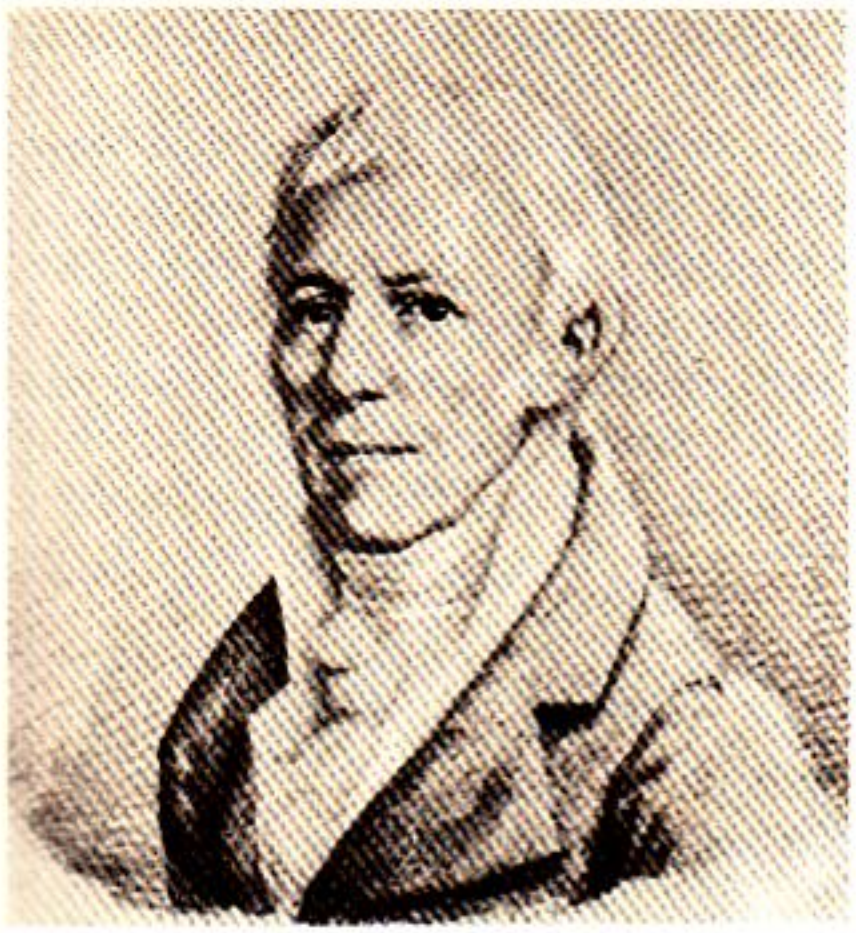
After that, he set his heart on becoming a musician, but was only able to secure a position as a bank clerk.

In the end, he grew interested in botany and became an acknowledged authority in this science, but was assigned to the chair of zoology and put in charge of its most difficult department — of worms and insects. A fifty-year-old botanist who had little knowledge of zoology, he had first to undertake a thorough study of the subject before he could teach anyone. And when he finally did qualify as a zoologist, he was elected to the Paris Academy as ... a botanist.

Life kept playing cruel tricks on Lamarck, but it also gave him something valuable — that post in the chair of zoology, which cost him so much mental torture and which immortalised his name.



An old Russian folk print with a description of "wonder bird which has never been seen by anyone" but which nonetheless was averred to have been in Paris on April 6, 1766.



Jean Baptiste Lamarck (1774-1829).

There were three departments in the chair of zoology at that time: of birds and mammals, fishes and reptiles, and worms and insects. The first two dealt with species of animals which were fairly well classified and arranged, but utter confusion reigned in the third division. Even Linnaeus had jumbled together hundreds of quite varied animals belonging to these classes, giving only superficial descriptions of them. Since there was no help to be expected from any quarter, Lamarck set about bringing order into this confusion on his own.

He began by trying to find some genetic principle in the group of animals he was supposed to study. And here he made an epoch-making discovery. He divided the entire animal kingdom into two large categories, the vertebrates and the invertebrates, a division which has been retained by zoology to this day.

Then he set about studying the invertebrates, and here one discovery followed another. He studied infusoria, molluscs and polypes, and finally suggested a system of his own which was greatly superior to that of Linnaeus. His system included the infusoria, which had been neglected by Linnaeus. It divided the animal kingdom into the above-mentioned two main groups — the vertebrates and the invertebrates — and it had 14 classes instead of Linnaeus's six.

His system, whatever his contemporaries might have though about it, was a great improvement over Linnaeus's, and it was bound to be recognised sooner or later. Especially since Lamarck gave amazingly accurate descriptions of many animals, particularly invertebrates. But the main thing was that the more Lamarck observed, studied and described, the more clearly he realised that the system of Linnaeus was not only erroneous in particulars but also in its very essence — in its premise that there were only as many species as God initially created.

Had it been the Middle Ages, such an assertion would have earned Lamarck death at the stake.

In the Middle Ages this heresy — for did not the Bible say that God created all animals on the sixth day of creation and thus they had remained ever since — would not have been overlooked by the Inquisition, which meted out death to all heretics.

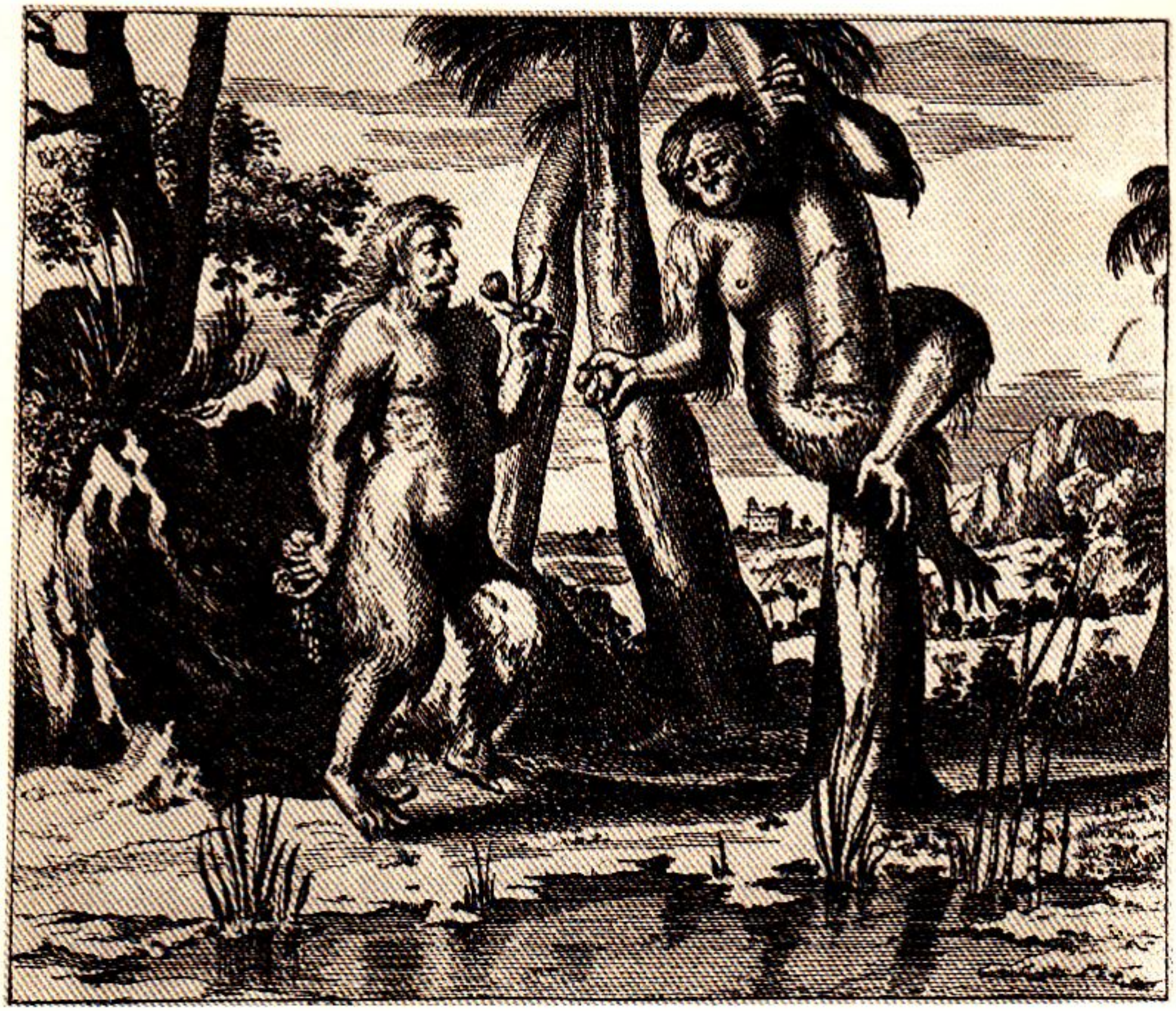
Nor were Lamarck's contemporaries prepared to countenance such an outrageous absurdity even though times had changed. Lamarck was not burned at the stake, but his theory was ridiculed, scorned, and rejected.

Lamarck did not give in but continued to argue his point. And his point

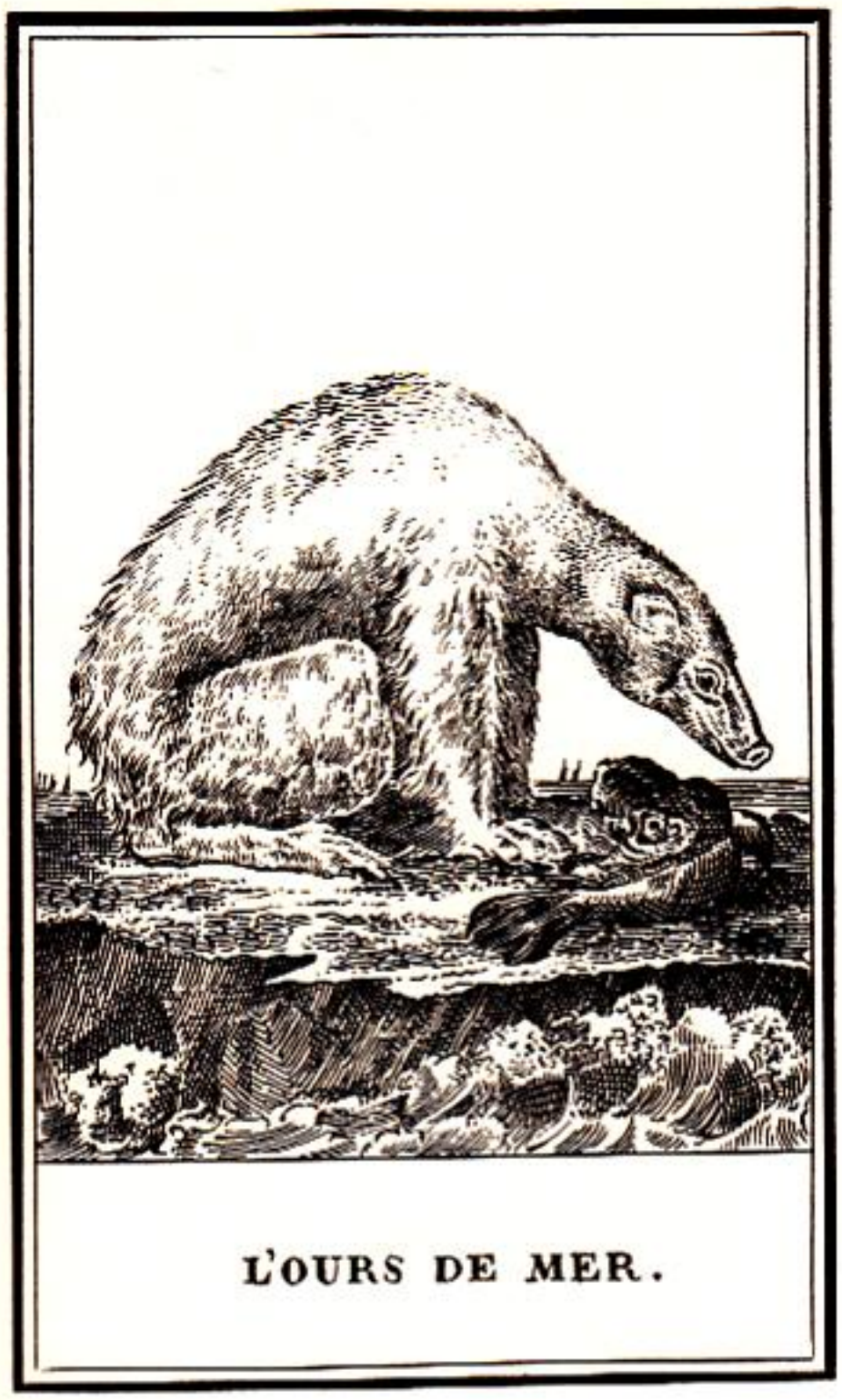
was that animals could be changed by their environment. If an animal found itself in a different environment, its needs changed, and with them changed its behavioural habits. And when its habits changed, so did some of its organs. Those which had been active in former conditions became passive, because they were no longer necessary, and with time they might become atrophied and disappear altogether or change their form.

Other organs, which had not been used much formerly, might, with constant exercise, also change their form and acquire new properties.

As an example Lamarck cited the giraffe. At one time, the giraffe had a short neck. But from constant efforts to reach the branches of trees, its



This drawing, representing ape-people, appeared about a hundred years before Darwin's theory.



The polar bear. (From Georges Buffon's book.)

neck stretched. Another example was the mole's eyes. Once this animal had eyes like all animals, but it had no use for them under the ground, so the eyes atrophied, and the animal became practically blind.

Not only external conditions brought about changes in organs, their disappearance, or the development of new ones. Other factors, according to Lamarck, were "internal motives" or "fluids".

In wild bulls, for example, "internal motives" — the desire and need to have a weapon — caused "fluids" to flow to their heads when the animal was angry and wanted to fight a rival. Gradually, these influxes caused horn structures to form on their heads which gradually assumed their present shape.

Birds who live near water needed to swim better. When moving their feet in water they stretched out their toes. This was not much use, so "internal motives" caused webs to grow between the toes, while the desire to catch fish caused their necks to stretch.

The changes acquired through environmental factors or "internal motives" were inherited by the succeeding generations, augmented from one generation to the next, and finally gave rise to a new form of animal.

Of course this reasoning was fallacious. But the very fact that Lamarck realised animals could change was a great stride forward in zoology. And it was from this premise that Lamarck proceeded while "introducing order" in the animal kingdom and creating his system. He did not merely describe animals; he tried to trace their kinships, to build a genealogy of the animal world. This approach was new in its very principle.

Lamarck's contemporaries did not recognise his system and did not appreciate his endeavour. Some because they saw nothing new in his discourse on the changeability of all living things (after all such views had been voiced before him, and they did not attach much importance to his incorporating these views into a system). Others rejected his system for the very reason that they would not admit changeability, even though Lamarck continually emphasised that "undoubtedly all things exist only by the Creator's will" and that everything that occurred in nature was done by His grace. By implication, he denied the precept that

all animals remained unchanged since they were created on the sixth day.

There were also those who denied Lamarck recognition because his ideas were not sufficiently substantiated by facts and were not convincing enough.

And, last but not least, a theory presupposing change was politically unacceptable in the early 19th century.

The French Revolution of the late 18th century brought victory to the big bourgeoisie over the monarchy and feudal aristocracy. But the bourgeoisie, once in power, found itself confronted with a new enemy — the workers and the artisans — an enemy much more fearsome than monarchy. The victors took fright and began to look for a means of escape, which they sought in "a strong arm", that would keep "the rabble" in check. Thus Napoleon came to power, and then the Bourbons were restored.

The bourgeoisie could feel at ease: strong power had again been installed, and again all was stable and unshakeable. Then suddenly, a certain Lamarck came up with a teaching about the changeability of all living things. This teaching undermined the foundations of society and weakened the people's belief in God. If everything was changeable, then the political system of the day was likely to give way to another. But, no, the bourgeoisie had had its fill of revolution. It had secured its position and it had no use for teachings propagating change.

Lamarck died in poverty, blind, and forgotten by everyone. Those who remembered him regarded him as a crazy old man.

The flamingo. (From Georges Buffon's book.)

Facts, Nothing but Facts and ... God!

In 1829, when Lamarck died, it was recalled that he had been a member of the Paris Academy and the custom was that a eulogy should be read for the deceased academician at a session of the Academy. Georges Cuvier was entrusted with writing and delivering the eulogy. But he never delivered it, for his "eulogy" contained nothing but mockery and denunciations, and the Academy declined to hear it.

Cuvier was an outstanding scientist, but he was at odds with Linnaeus's

system, while Lamarck's system infuriated him beyond all measure. He regarded it as insane ravings. Wasn't it insanity to question the omnipotence of the Creator, to suggest that He had not created things once and for all? That was what Lamarck in effect did, whatever his reservations. Cuvier, for his part, never breathed a word of doubt in God's omnipotence, though he often found himself in a quandary when facts did not fit in with the Bible. But Cuvier invariably found a way of reconciling the two. It was precisely to reconcile facts with the Bible that he devised his famous "theory of catastrophes".

Cuvier did not win fame by his efforts to fit scientific facts in with Christian canons. For all that he attacked Lamarck, defended the Bible and insisted on a literal interpretation of the "Act of Creation", objectively, with his own research, he paved the road for scientists to later establish beyond all doubt that living things were subject to change. Cuvier accumulated enormous material and became the founder of two important biological sciences — comparative anatomy and palaeontology. His second god, so to speak, was Fact.

To be sure, there had been enough lovers of facts and experiments before Cuvier. More than five centuries before Cuvier was born, "doctor mirabilis", Roger Bacon, insisted on facts, too, but was prevented from expressing his views, banned from Sorbonne University and then imprisoned on charges of sorcery. Roger Bacon spent a total of 24 years in prison for preaching study through experiment rather than by theorising.

Four and a half centuries later, the Royal Society was set up in London. For its motto it chose the words of Roger Bacon's namesake, Francis Bacon: "Nollius in Verba", that is, truth lies not in words but in experiments and facts.

Georges Cuvier (1769-1832).

There had also been other scientists who preferred facts to words. But none of them prized facts so highly or accumulated such a vast stock of them or could deal with them as competently as Cuvier.

Anatomy was known before Cuvier, but it was he who established the science of comparative anatomy.

He began with molluscs. It so happened that in his youth, he spent several years in Normandy. His tutoring duties with the children of Comte d'Héricy did not overburden the eight-

een-year-old Georges Cuvier. He had enough time to observe nature, to dissect animals, fishes, birds and molluscs, to take down his observations, to draw (Cuvier was a gifted artist) and to think. In the end he came to the conclusion that Linnaeus's theory was very imperfect, especially the part that pertained to molluscs: Linnaeus classified them according to external features, while Cuvier was guided by the molluscs' internal structure.

But he did not reach his final conclusion until he moved to Paris upon the invitation of Saint-Hilaire, a young but already eminent scientist. In Paris, Cuvier arrived at the conclusion that the mission of science was not to describe species of animals but to study their organs.

Thus, the beginnings of the science of comparative anatomy were laid.

Cuvier went on dissecting animals and comparing the structure of their various organs. Gradually he realised that a body was an integral whole in which each organ fulfilled a definite function, and where a change in any one organ entailed a change in all the others. This meant that the structure of every organ was bound up with the overall structure of the animal. For instance, if it was a ruminant animal, it would have flat, wide teeth, a long intestinal tract, a big stomach, and hooves. Beasts of prey, on the other hand, would have sharp teeth, and their feet would be such as to make pursuit of prey easier.

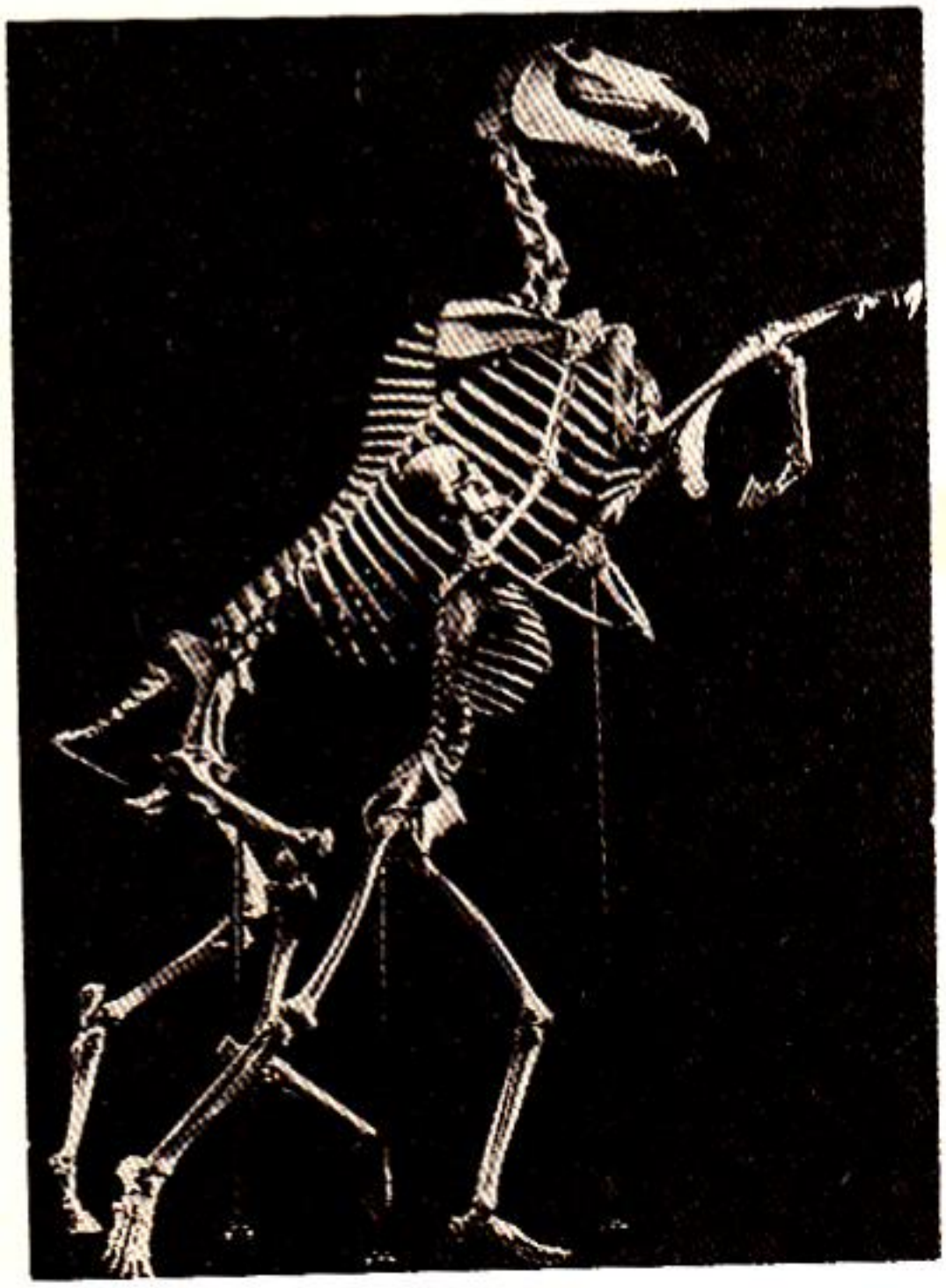
This was a remarkable discovery, especially since this theory was supported by hundreds of preparatory studies, drawings, skeletons, etc.

Thus Cuvier became quite famous and was launched on a brilliant career. He received a high appointment, and

Deer.

ever after, up to his death, he held important government posts. He was inspector of lycées, chancellor of the University, member of the Council of State, President of the Committee of the Interior, and Director of the Department of Non-Catholic Religions. Eventually he became a peer of France. Government service — and Cuvier did not consider it a burden — took a lot of time. Yet he never abandoned his research even for a day. He used his every free minute to read and write — during travelling, in a coach, waiting for dinner, etc. And not just write, but produce impressive works containing acute and accurate observations, ingenious suggestions and a multitude of facts.

While studying the anatomy of animals, their internal structures and skeletons, Cuvier became interested in palaeontology, the study of extinct ani-



Skeletons of a man and a horse.

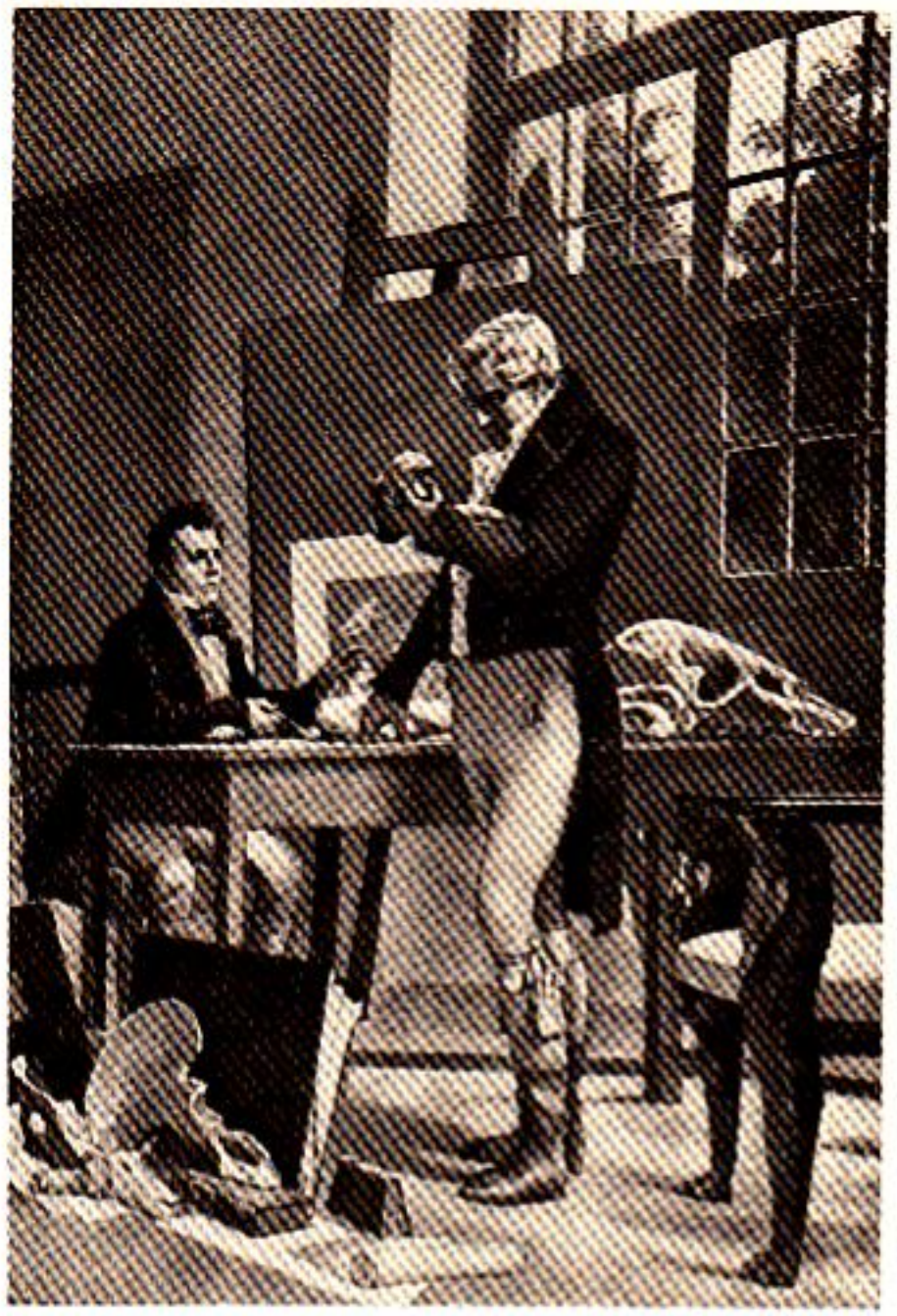
From bits of bone Cuvier was able to reconstruct the appearance of Earth's early dwellers, and he was so many times proved accurate that his contemporaries thought him to possess nearly magic powers. Among the many animals he restored and described were the Irish "peat" deer ... and the mastodon.

mals. Bones of such animals were being found in great numbers during excavation works. They were brought to Cuvier, and he reconstructed skeletons of extinct animals proceeding from his theory of interdependence of all bodily organs. Since each part of a living organism was part of an integral system, he argued, not one of them could change without causing others to change as well, and, consequently, each part taken on its own provided indications as to the others.

Cuvier restored, from individual bones, the skeletons of more than 150 extinct animals, doing it with an accuracy amazing for that time and that level of knowledge. But, while doing it, Cuvier the scientist and Cuvier the materialist clashed with Cuvier the idealist, Cuvier the believer. If God really created all animals, and they had not changed since, wherefrom all those monsters? They no longer lived on earth. What had happened to them? Had they died out? Or changed drastically? If one were to assume they had died out, where had the animals now inhabiting the earth come from? Their bones were not found beside the bones of ancient dinosaurs. And if one were to assume they had changed... No, Cuvier could not permit this heresy. Instead he produced the "theory of catastrophes".

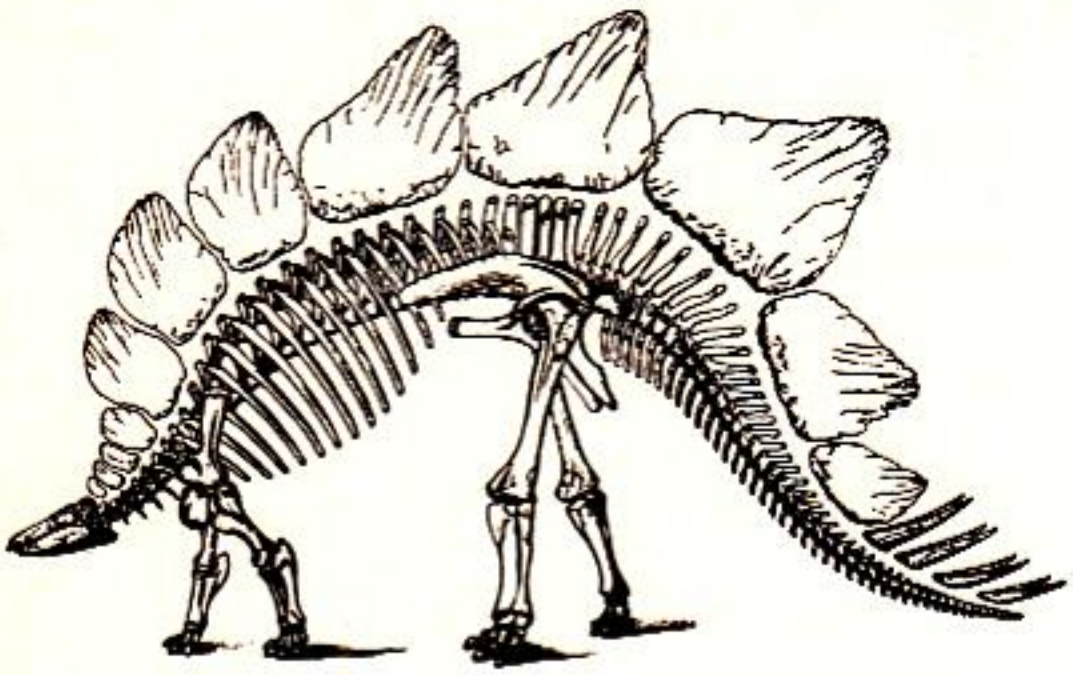
This theory was an attempt to reconcile the facts of science with Christian dogma, that is to reconcile two irreconcilables.

The theory supposed that our earth from time to time was flooded by seas and oceans, that mountains rose suddenly and the sea-bed became dry. All this happened unexpectedly, and the animals inhabiting the dry land and the sea were unable to escape and were killed. It was their bones that were found during excavations. But the catastrophes were local in character and did not destroy all life on earth. With time, the survivors — the horses, cows, dogs and cats that we know, which also lived in old times but elsewhere — migrated and populated, say, Europe in place of the mastodons which had perished.



Cuvier's secretary barely managed to keep up with his employer's dictation.

Having thus accomplished a reconciliation between facts and God, Cuvier turned his attention to other matters. Linnaeus's system displeased him in many respects but mainly because Linnaeus grouped the animals too artificially, mainly by external features.



Another prehistoric animal whose skeleton Cuvier reconstructed.

So Cuvier elaborated his own theory, which came to be called the theory of types. His own name for the various types of animals was "species". He distinguished four of them: vertebrates, molluscs, articulates (insects and some worms) and radiates. All the rest were classed as invertebrates.

Each "species" was divided into classes, but Cuvier did not recognise any connection between the types. Of course he didn't! If he had admitted their kinship, he would also have had to admit the changeability of animals. And this he was not prepared to do.

The theory of types had many errors and shortcomings, the principal one being the separateness of the "branches". But the system of classification as such was a good one. And, in a modified form, it became the basis of modern classification of animals. Herein lies the importance of Cuvier's work.

We owe him no less for founding the science of comparative anatomy, which proved as essential for subsequent study of animals as the theory of evolution.

As soon as he closed his eyes, the same vision haunted him — boundless ocean and blazing fire in the blackness of a southern night. His ship was on fire.

Wallace would come to with a start and open his eyes, but the vision did not vanish immediately — the tragic event had left too deep a mark on his memory. It was a frightening experience, that fire on board ship in which he nearly perished and the subsequent ten days of floating on the ocean in a lifeboat tormented by hunger and thirst. But the really heartbreaking thing was the loss of all his collections and the notes, diaries and notebooks he had put so much effort into.

Alfred Wallace had spent four years in the Brazilian jungle along the Amazon and its tributary, the Rio Negro. He had amassed a great number of precious collections and made a host of fascinating observations and notes. And now he was back in London, practically empty-handed, and not much better off than when he had dreamed of distant journeys with his brother, who had died of yellow fever in South America, and a young teacher named Henry Bates.

They had only managed to save enough for their boat fares to South America, but their dream had come true. They had seen so much and made a multitude of discoveries. If not for the fire on the ship on his way back, he could have told innumerable interesting things to naturalists, and could have shown his collections as well. Wallace had counted on selling part of his collections and using the money to go to the Malay Archipelago, which

was as little known as South America. But now the trip was utterly impossible.

Wallace was lucky, however, lucky and energetic. He managed to find financial backing for his trip to the Malay Archipelago — from a rich collector and from scholars who needed animals living in that part of the world. With the money thus raised, he again left England in 1854, to return eight years later, an experienced naturalist and a scholar of wide repute. He had walked, ridden and sailed the length and breadth of the archipelago. He brought back piles of diaries and notebooks and discovered hundreds of animals previously unknown to Europeans. His collection of insects contained more than a hundred thousand specimens, of them 15 thousand butterflies and 83 thousand bugs. Altogether he brought back some 125,500 specimens of insects, birds and animals.

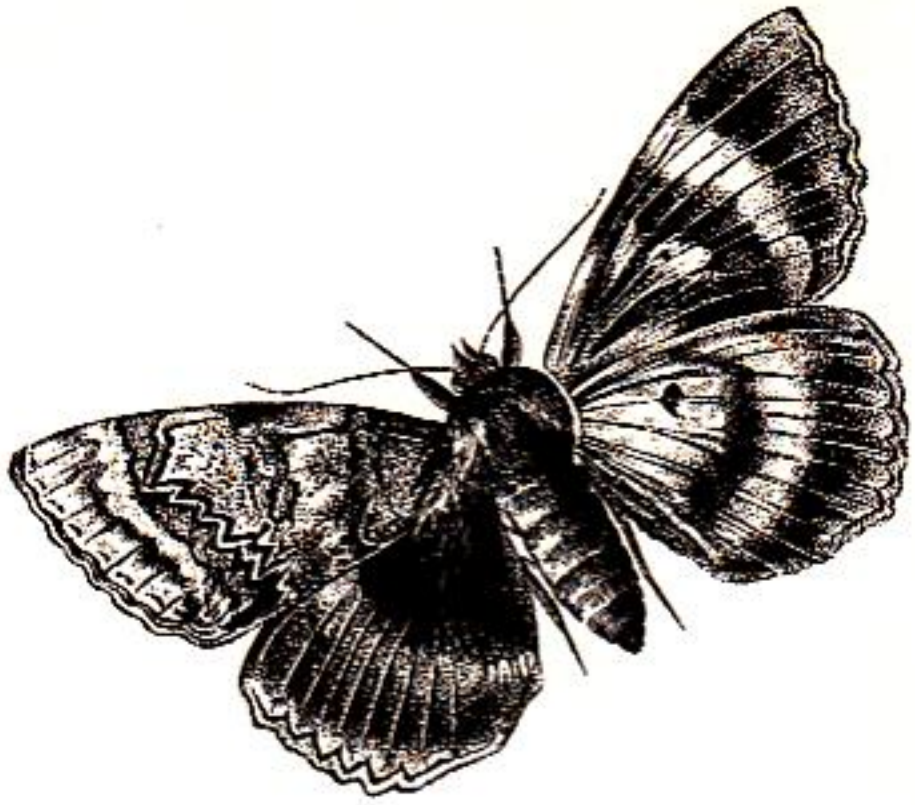
Wallace's return to his mother country was truly triumphal. And not merely because the ship's hold brought rich collections with hundreds of animals unknown to science, but also because he had proved his worth as a man of courage, modesty and scientific integrity, and a profound thinker who had arrived independently at an understanding of the fundamental problem of biology.

Alfred Wallace was a born naturalist, a born hunter and collector. This is how he described to his friends the catching of an unknown butterfly: "The beauty and brilliancy of this insect are indescribable, and none but a naturalist can understand the intense excitement I experienced when I at length captured it. On taking it out of my net and opening the glorious wings, my heart began to beat violently, the blood rushed to my head, and I felt much more like fainting than I have done when in apprehension of immediate death. I had a headache for the rest of the day, so great was the excitement produced by what will appear to most people a very inadequate cause."

Yes, he was a born hunter and collector. But he did more than observe, collect, catch butterflies and hunt. He thought, compared, and drew conclusions. Despite the many hardships he encountered and his isolation in the wilderness, in 1855, he wrote an article, "On the Law Which Has Regulated the Introduction of New Species", in which he spoke of the changeability observed in the animal world and of the emergence of new species. Yet, though Wallace established the fact of evolution, he could not as yet reveal its causes.

So he went on travelling, collecting, observing, and thinking. And finally he arrived at an explanation — the motive force of the change of living organisms was the survival of the fittest. The weak, those who could not adapt to the conditions of the environment, perished. And so gradually, over thousands of years, as the conditions of life changed, the animal world changed as well. Testimony to this was variants of the same species of animals he found on the islands. A variant was the beginning of a new species. After many generations, it would establish itself and acquire its own stable features. And some representatives of this new species would again exhibit deviations, and a variant of yet another new species would gradually emerge. And so the process would continue.

Wallace was so taken up by these thoughts that he was impatient to sit



The ordinary underwing moth (both sides of wings). Many entomologists described this butterfly, but it was Wallace who discovered its secret.

Alfred Wallace (1823-1913).

down and write an article expounding them there and then. But he was incapacitated by a severe attack of malaria. Tossing on his bed in high fever, he went on thinking about his discovery, and as soon as he felt a little better he would demand a sheet of paper and write until the pencil fell out of his weakened fingers in a new bout of the disease. As soon as he was able to get out of bed, his legs barely supporting him, he sat down to his article in good earnest and finished it two days later. It was despatched to England with a London-bound ship.

Wallace's article made a tremendous impression on naturalists in England. To imagine that a man so far removed from libraries, museums, and scholarly disputes should be the first to publish an article on a subject which Charles Darwin had been working on for more than twenty years! Darwin had arrived

at the same conclusion, and his arguments were thoroughly substantiated and much more convincing. But Darwin had not yet published the results of his twenty-year efforts. Would priority go to Wallace then?

Yes, formally Wallace had priority. Yet, when he was informed of Darwin's studies, he replied that if Mr. Darwin had made such a thorough study of the question he, Wallace, was prepared to forego the right of priority.

In addition to being an excellent hunter and collector, as well as a brilliant scholar, he was also a man of noble principles. This he confirmed once again on his return to England by putting his diaries and notes at Darwin's disposal. On Darwin's request, he elaborated a number of problems for his fundamental work *The Origin of Species*, and he also published his own book about natural selection which he called interestingly enough, *Darwinism*.

Wallace wrote many more books about his journeys and observations and, in 1876, he published a major two-volume work on zoogeography, *The Geographical Distribution of Animals*.

Zoogeography is a science that deals with the distribution of animals. It also studies changes in animal species from region to region and the causes for the appearance or disappearance of one or another species in certain geographical regions. Attempts to describe the distribution of animals had also been made before, but the explanations of why animals were distributed in this way and not any other were extremely naive. Linnaeus, for example, considered that in the beginning, all animals lived on some island in the tropics. In the middle of the island was a mountain. On its top lived arctic animals created by God. At the foot of the mountain lived tropical animals. When the sea became shallow, the animals ran off helter-skelter and each group came to occupy the region assigned to it.

Other scholars produced different theories, some very far removed from the truth, others approaching it. But zoogeography did not become real science until the law of evolution of animals was discovered.

Wallace's work on zoogeography was a major contribution to zoology. His name was immortalised in the zoological regions he marked, which came to be known as Wallace regions. And, most important, Wallace laid the foundations for the science of zoogeography.

The Battle of Oxford

Saturday, June 30, 1860, saw great activity near the museum of the famous Oxford University. Resplendent coaches drew up at the entrance one after another, and from them alighted bejewelled ladies and frock-coated gentlemen. Students and dons also converged on the museum, and there were many black cassocks of the clergy.

Only a small proportion of those who had flocked to the University museum that day had any real interest in science. The majority had come to hear Bishop Wilberforce, a popular speaker and preacher, whose sermons always attracted great audiences. And this Saturday the bishop was expected to annihilate the godless Darwin.

There was a smell of scandal in the air. For more than six months now, the name of Charles Darwin and the title of his book *The Origin of*

Charles Darwin (1809-1882).

Species were bandied about by newspapers and magazines. The critics vied with each other in scornful denigrations.

Some called Darwin's theory "a cable woven of soap-bubbles"; others regarded it as an "innocuous after-dinner dream". Still others accused Darwin of immorality, while another group... Well, there is no point in enumerating all the taunts Darwin was subjected to. He was not worried about the booing of ignorant newspapermen. What concerned him were the ostensibly "scientific" articles in some magazines which misrepresented his theory, garbled his facts and distorted his meaning.

Naturally enough, the church joined in the fray with great gusto. His theory threatened the church more than the rest, dealing, as it did, a crushing blow to the Bible and the myth about the creation of the world.

Not that Darwin was the first. A hundred years ago, the Frenchman Jean Meslier had voiced a conjecture about the changeability of the animal world. But nobody paid any attention to him. Then there was Lamarck, but Cuvier made short work of him. However, Darwin was a very different proposition. He was a scientist of established reputation, and he was not alone as poor Lamarck had been. The times had changed, too. Two centuries before, both the book and its author would have been consigned to the flames. Now the church did not have such effective methods at its disposal — the days of the Inquisition were long past.

Yet the church had plenty of fight left. And so Bishop Wilberforce mounted the rostrum.

The dispute had to be moved to a bigger auditorium, the museum's library, but even that failed to accommodate all. The bishop was only too pleased — the more people heard him the better.

He was a skilful speaker, well versed in oratory. He began at a low pitch, refrained from attacks on Darwin, and seemed to be rather sharing his doubts with the listeners. Where had Darwin taken the facts he was citing in his book? Who had ever seen animals change? Oh, so it had happened over centuries? And where were the proofs? All of Mr. Darwin's assertions were unsubstantiated and could not be taken seriously. The bishop ridiculed Darwin at one moment, and pitied him the next. And only when he spoke of the insult Darwin had dealt to religion did his voice assume a solemn tone and sound like a clarion call.

The audience was impressed — at least the ladies and gentlemen were — and the bishop felt sure of success. But he had not reckoned with the other members of the audience who were better versed in science than the aristocracy, and the bishop himself for that matter. The bishop forgot that he was not dealing with a faithful flock who drank in his every word like gospel.

The next to speak was Professor Huxley. He was seeing red, but held himself well in hand. He was not concerned with oratorical effects; what he dealt with were facts. Before turning to Darwin's theory, he dissected the bishop's speech, pointing out gross scientific errors he had uttered. Deferential parishioners would never have noticed them, but this was university and not a parish church. And a speaker would never be forgiven mistakes impermissible for a first-year student. The gilt peeled off the bishop's eloquence.

Surely the bishop could not be wrong and Darwin right!

A seasoned polemist, Wilberforce might have been able to strike back, but for the all-important revelation that he had not read Darwin's book.

One after another scholars mounted the rostrum. Proofs? There were any number of them. They were contained in Darwin's book and they spoke for themselves. The audience was beginning to realise that the bishop had lost the battle. Of course, he still had the right to make his concluding remarks. What would he say? Perhaps he would be able, despite everything, to crush the defenders of that blasphemous Darwin?

But the bishop left the auditorium without uttering another word, followed by the black-clad clergy and some of the gentle folk. But the majority remained and a lively discussion continued for hours, the students cheering Darwin and those who had stood up for him. "The Battle of Oxford", as the newspapers dubbed the dispute, ended in complete victory for Darwin and his teaching, a victory not merely over clerics but over all reactionary thought.

Charles Darwin's first book, *Journal of a Naturalist* came out in 1839. It was published upon his return from the surveying expedition on the ship *Beagle* on which he held the post of naturalist. Had the twenty-two-year old amateur zoologist starting out on the *Beagle* been told he would one day become a great scientist and work a revolution in mankind's world outlook, he would have been extremely surprised.

But that is exactly what happened.

Darwin returned home from the expedition, which lasted five years, a mature naturalist, bringing along a vast amount of notes and specimens. After the two-volume *Journal of a Naturalist*, he published *Zoology of the Voyage of the "Beagle"* in four parts, and several books on geology. His name, followed by an impressive train of academic titles, ranked with those of the world's major scholars. He had been elected to many scientific societies. But fame was the last thing to interest Charles Darwin. He was preoccupied with his own thoughts, with the theory that was taking shape in his mind.

It was clear enough to him that the animal world was by no means immutable. But why, by which force were the changes wrought? He was not content to accept Lamarck's theory of "internal motives". He was working out a theory of his own.

He would spend hours in the garden watching plants, making some kind of calculations and amazing the gardener with his odd behaviour.

He built a dovecote, bought pigeons and crossed different breeds, to the vast displeasure of all the local pigeon-fanciers.

He collected an enormous library, including thousands of books and innumerable newspaper and magazine cuttings. He filled hundreds of notepads with observations and the ideas they aroused. And the more facts he accumulated, the firmer the conviction grew that the "perfection" and expedience of the animal and plant kingdom, so haunted by the church and allegedly testifying to the wisdom of the Creator, were the result of none other than the struggle for survival.

This applied to both animals and plants.

It is known that most plants yield a vast number of seeds. Kliment Timiryazev calculated that by a very conservative estimate, the progeny of one dande-

lion plant (if all its seeds germinated) would in ten years occupy a territory fifteen times the entire surface of the dry land on Earth.

In only one summer the progeny of one housefly, if they all survived, would, if lined up in a column, reach the Moon.

Even the progeny of a pair of elephants would reach the fantastic figure of 19 million head in 750 years, and this despite the fact that elephants multiply at a much slower rate than other animals. This does not happen because the majority of plants and animals perish, and only the fittest survive. And what does the fittest mean? The strongest? The ones with the most endurance? No, it all depends on the conditions of existence.

If, among butterflies which have protective colouring resembling tree bark, appear some whose colouring provides better camouflage, they have a greater chance of survival because birds will have greater difficulty seeking them out. In the end, only those butterflies with this better adapted colouring will survive. Would this be a new species? Not yet. But the progeny of these butterflies will be subject to the same process of natural selection, as Darwin called it, and the useful qualities will be strengthened. After many successive generations, a new species will take shape. In this case, the colouring will have played the leading role in the struggle for survival. But there are many more kinds of struggle for survival: struggle against other species, or struggle for survival despite unfavourable natural conditions, or against other representatives of the same species. Sometimes this struggle for survival is a mixture of several or all possible variants.

All this Darwin expounded in his book, supporting his conclusions with thousands of facts and examples. He spent nearly twenty years working on it, and he might have worked even longer, because be wanted to adduce more and more facts in support of his arguments, had not he received Wallace's article.

His friends insisted that he publish his book at last, and it came out on November 24, 1859.

It was a smallish green volume with a long and rather tedious title *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.* Yet all 1,250 copies of it were sold out on the very first day it reached the bookshops. It is hard to say how news of this book reached the reading public. Maybe Darwin's friends had done some advertising, or maybe the rumour went about because Darwin had published several articles on the subject previously; at any rate, the book was bought up with lightning speed.

In the beginning, the press was favourable; Darwin's friends and supporters welcomed the work while his enemies and opponents had not had time to make up their minds and were keeping their peace for the time being.

Then all-out war was declared on it, which ended in the Battle of Oxford.

Darvin won, and the truth won, thus clearing the road for the further progress of science.

Mankind's road to the truth was long and beset with dangers and sacrifice, barred by the fires and dungeons of the Inquisition. Darwin's teaching on natural selection brought mankind to the truth in the field of biology. Darwin explained and proved why all life was expedient and how all living things adapted to their environments. Moreover, he proved that this expediency was conditional,

i. e., that it worked only given specified conditions.

When the conditions changed, this "expediency" might very well turn into its opposite and spell the doom of the animal or plant.

The theory of natural selection established that all living things had a single origin. While Cuvier asserted that the animal world was divided into "species" which had no connections among themselves and nothing in common, Darwin proved that the animal world was like the many branches of a huge tree with common roots, and a common trunk. Modern animals were the descendants of those which lived hundreds, thousands and dozens of thousands years ago. And in order to know about the descendants, one had to know about the forebears.

The victory at Oxford did not mean Darwin's enemies gave up their struggle against him — on the contrary, they continued it with renewed vehemence, but they could not stop the march of science. Zoology (and biology in general) finally had a solid foundation, and many people developed a lively interest in the animal world. A few books about animals had been written by that time, but most of them lacked veracity. What was needed was a book based on the new system of classification that took account of contemporary knowledge about animals while, at the same time, being accessible to the general reader.

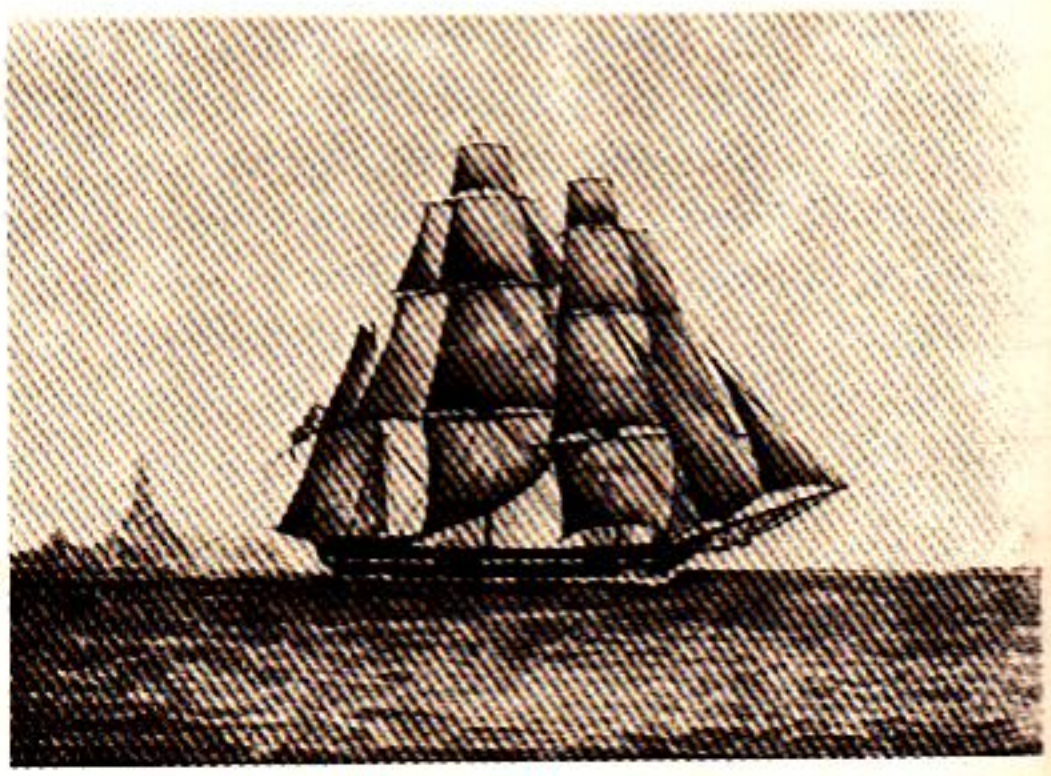
Such a book was to appear shortly. It has been read for more than a century by many generations of animal lovers, has helped to educate many naturalists, and has rendered invaluable aid to many zoologists.

The title of the book is *The Life of Animals*. And the name of its author is Alfred Edmund Brehm.

The Life of Animals and Its Author

He raised his gun and took careful aim. But he never pressed the trigger. He was an excellent marksman and passionate hunter but had a great fondness for live animals and birds. He could spend hours watching them, memorising their colouring and their habits and behaviour down to the minutest detail — so that he could write them down in his diary afterwards. Yet he had to kill animals as well, because he had to bring to Europe skins and stuffed birds unknown there.

But this time Alfred Brehm refrained from shooting: the pink flamingoes were so lovely, he could not bring himself to kill such a bird. He was annoyed with himself — he might not have another chance for a long time, but he tried to justify his hesitation by the fact that his hands were still trembling after a recent bout of malaria, and he would have missed anyway. Malaria tormented him,



The Beagle, *the ship that became famous in the history of science because the young naturalist Charles Darwin made a round-the-world voyage in it.*

Even before Darwin people had observed the mocking birds on Galapagos Islands. But nobody had bothered to wonder why they looked so different though living side by side.

and so did the lack of money and the state of suspense he found himself in.

In the beginning, everything seemed perfectly straightforward. Before leaving for Africa, Baron von Müller sought out a specialist in ornithology. He needed advice, and he also needed a young and vigorous companion for his trip, one who knew and loved nature. When he came to Pastor Christian Ludwig Brehm, who was one of the greatest authorities in ornithology at that time, he managed to kill both birds with one stone. The pastor, subsequently Honorary Doctor of Jena University, the author of a three-volume monograph about birds and the owner of a huge collection (10,000 specimens), gave Müller exhaustive answers to all his questions, while the pastor's son, eighteen-year-old Alfred proved to be just the kind of person the baron was looking for to accompany him.

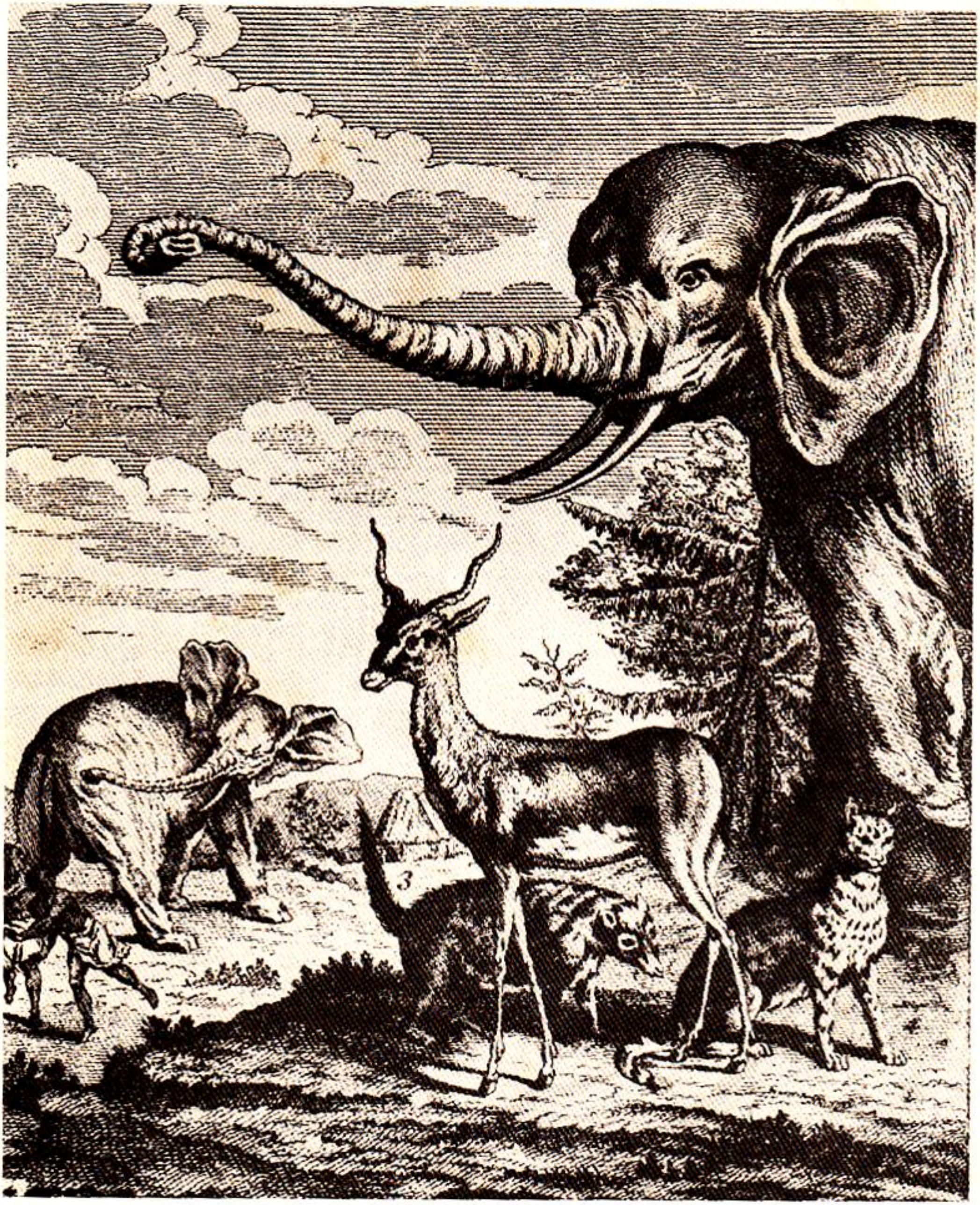
In the course of two years, they had walked, ridden and sailed hundreds of kilometres. They made their way into localities where a European's foot had never trodden; they starved and suffered from thirst and had any number of hair-breadth escapes from wild beasts and from the natives who mistook them for slave-traders. But Alfred took it all in his stride as long as he could travel and observe the wonderful animals.

Thus they spent two years, and then Müller went to Europe for fresh supplies and never came back. Eventually, Alfred learned that the baron had lost his fortune, which meant that Alfred was stranded in Africa without any money. He did not even have enough for a fare to Europe. And yet he had to get back, and not just get back but bring the captured animals and the collections.

In the end, he managed to borrow some money and started for Cairo from whence he was to sail to Europe. He was terribly home-sick and counted the days left before he would see Europe again, but he was not destined to return for another three years.

In Cairo, Brehm met a prominent zoologist who suggested that he should accompany him on a trip through Africa. Eager though Brehm was to return home, the temptation was too strong. So he only came home in 1852.

Soon an odd kind of student appeared at Jena University. A sturdy, rugged man with a courageous weather-beaten face, he amazed the lecturers with his



An illustration from an 18th-century book about animals.

broad knowledge and the stories of his adventures. As for the students, he amazed them with his room, which was more like a zoo. Only the animals here did not stay in cages but roamed freely about. Of course they were small animals, not like the tame lioness Bageera and the baboon he had kept in Khartoum. But he shared his room with a mongoose, a monkey and several parrots.

Three years later Alfred Brehm moved to Vienna. When he started on his trip to Africa as an eighteen-year-old youth, he imagined that a traveller needed, above all, strength, stamina and courage. He came back with the realisation that a traveller must be armed, above all, with knowledge.

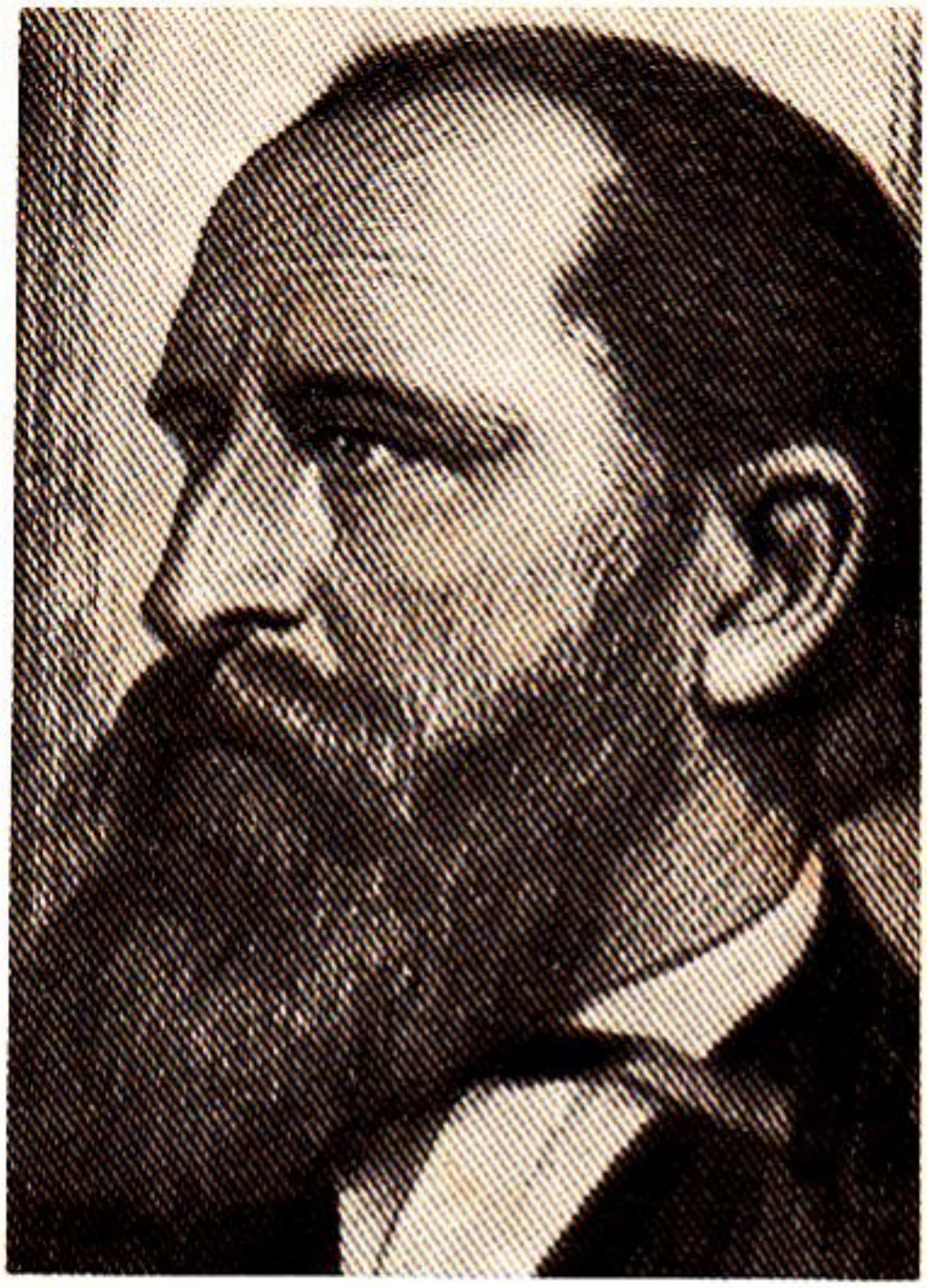
At Jena, and later Vienna universities he made a thorough study of zoology. Mind you, before his trip to Africa he was thinking of a career as an architect, and zoology was no more than a hobby.

After graduating from Vienna University, Brehm went to Leipzig and began to teach in a high school.

This was a memorable time, for both the teacher and his pupils. As he told the class about the various animals, he lived his adventures anew, as it were, while the pupils listened with such rapt attention that they forgot their prosaic surroundings and imagined themselves in an African jungle, feeling the heat of its sun and hearing the roar of a lion.

It was probably their interest in his tales which induced Alfred Brehm to start writing. At any rate, before long he published his first stories, followed by his first book about animals *Die Tiere des Waldes (Animals of the Forest)*. Earlier, he had published his travel notes in three volumes.

Brehm soon discovered, however, that walking along paved streets and



Alfred Brehm (1829-1884).

sleeping in a comfortable bed was not to his liking. He much preferred traipsing through desert, wandering in the jungle and sleeping in a tent.

Ethiopia and Spain, Norway and Lapland, Hungary, Sudan, Rumania, and even Russia, or rather, Siberia, where he nearly reached the Kara Sea — such was Brehm's incomplete itinerary.

In between journeys, he wrote articles and books and delivered lectures. All of them were inspired by the one great passion of his life — love for animals. And it was an active kind of love. He sought to inform people about animals and birds so they could treat them reasonably and protect them from destruction.

While journeying in Spain, Brehm saw heaps of game for sale at market-places. He was a hunter himself and knew that hunting within reasonable bounds could do no harm to the bird population, and that the selling of dead birds at market-places was quite natural. But what depressed him was that among the dead birds there were many small songsters, such as finches, nightingales, and swallows, which had very little to offer in the way of meat.

How could he explain to people that they were doing themselves inestimable harm by destroying these birds? To be sure, he could talk to two, three, or even fifty sellers, but would that be any use when there were hundreds of such "hunters", who killed every living thing within reach?

No, he had to write books, to tell people about animals, about their importance, and about the need to protect them.

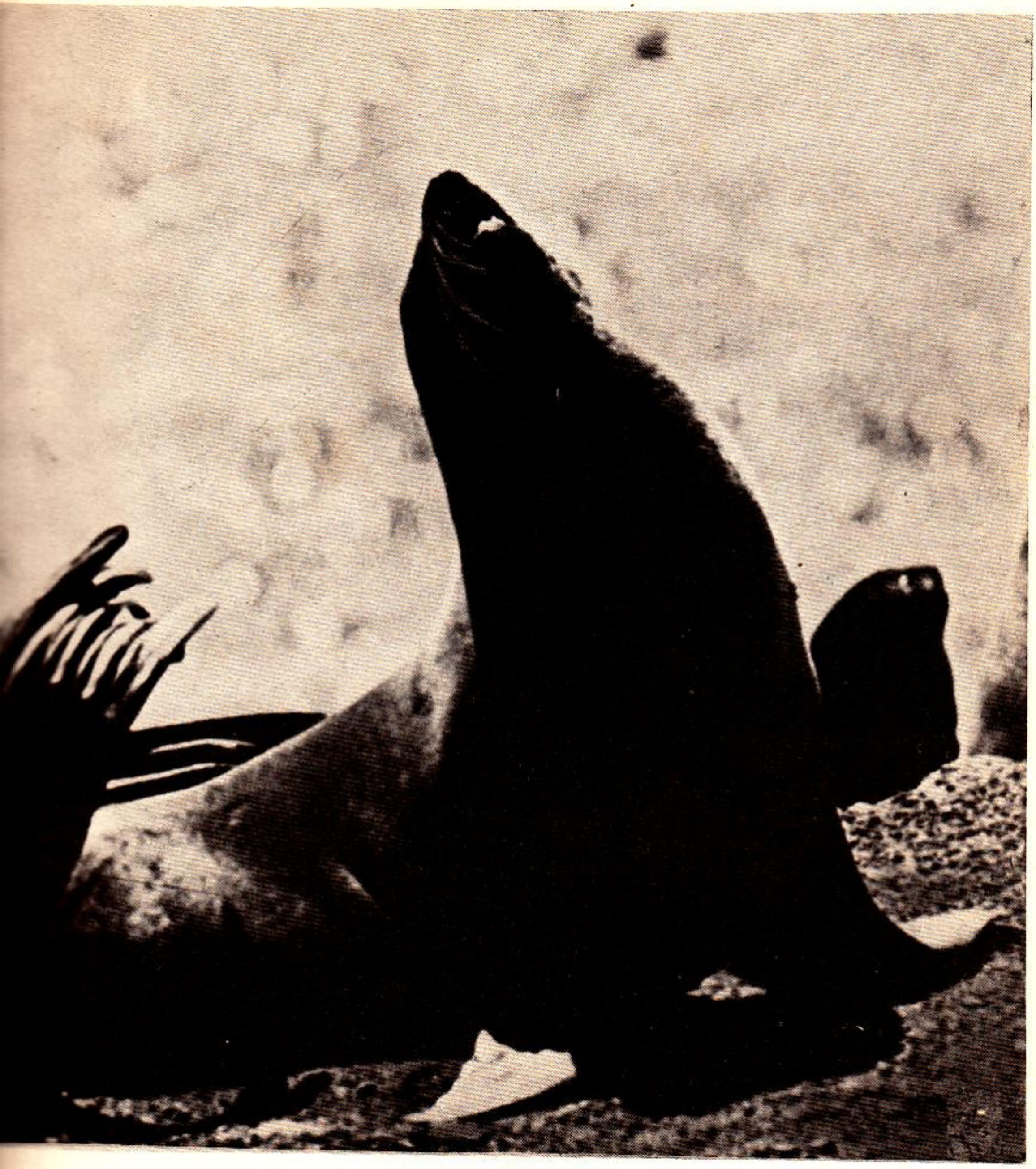
Thus the idea was born for the book *The Life of Birds.*

With each new book, Brehm's popularity grew among both zoologists and lay readers. Businessmen also began to take an interest in him. The owners of the Hamburg Zoo offered him the post of director. They counted on his name to lend prestige to the zoo. Also, a man with such energy and practical astuteness will make the zoo a really profitable enterprise.

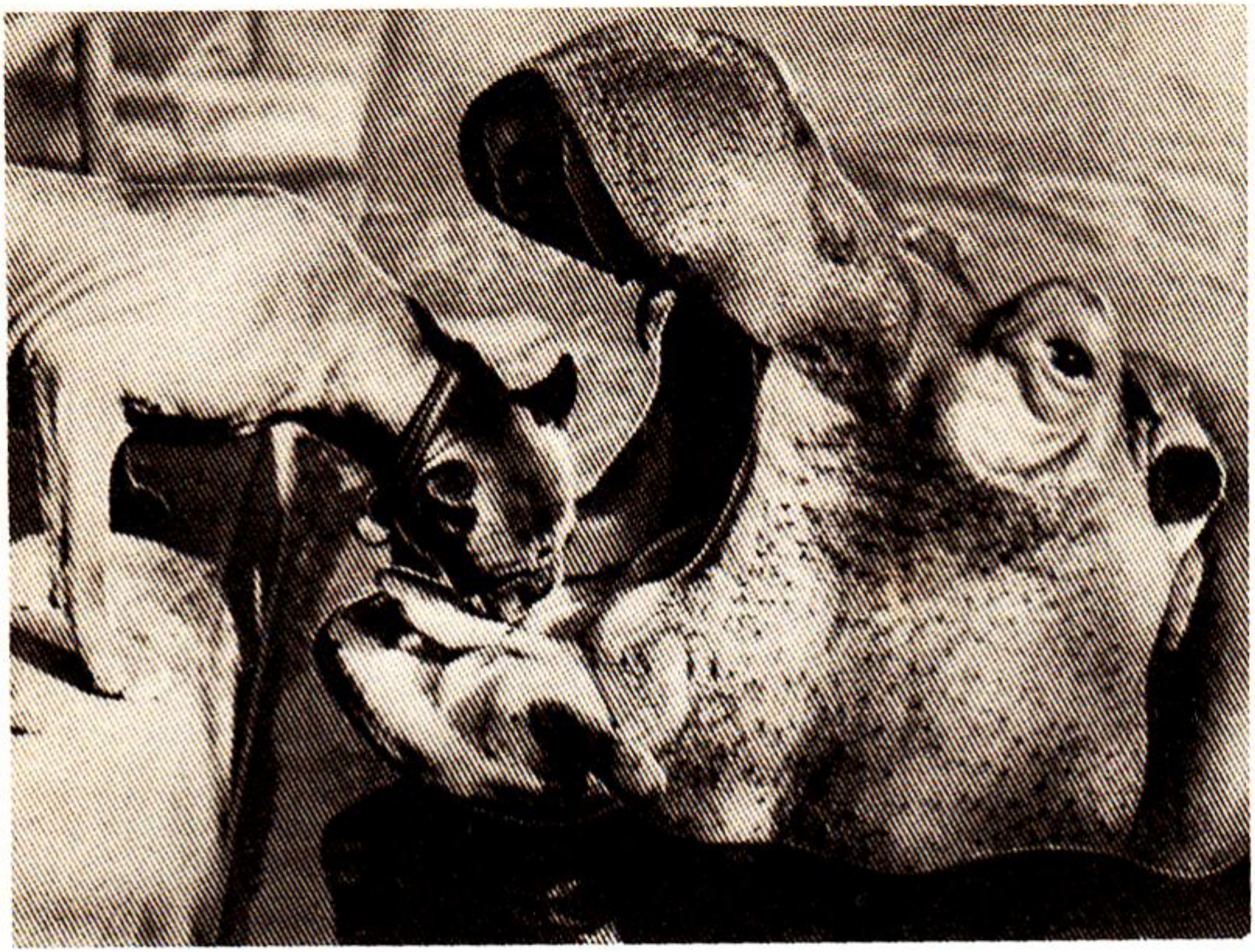
But the owners reckoned without the host.

Not everybody went to the zoo just to see animals. Some came in search of thrills: they were not content to see a tiger or lion dozing behind the bars in his cage. They wanted to see the beasts baring their fangs in fury and hurtling themselves against the bars.

To please such visitors, the attend-



Sea lions. It's clear enough that they live in the sea, but why lions?



At every step you encounter amazing, unusual and moving things in the world of animals.

ants, with full permission of the owners, thrust sticks into the cages and poked the animals, driving them into a frenzy.

The public were permitted to play any kind of trick on such harmless animals as hares, foxes and monkeys, for did they not pay money for their amusement?

Brehm put an end to all this. He punished attendants for baiting animals or for letting the visitors do so. The staff of the zoo used to steal a large share of the animals' food. The owners shut their eyes to those goings on — it did not matter much as long as the animals did not die.

Brehm stopped these thieving practices as well.

The owners had economised on space and kept the animals in tiny cages. Brehm demanded that the zoo should be reconstructed, and that tolerable conditions should be provided for the animals.

While all the owners cared for were profits, Brehm was primarily concerned with the well-being of the animals.

Naturally, there was no reconciling these two opposite points of view, and after a struggle which lasted four years Brehm had to resign.

He devoted himself to writing.

In describing animals, his predecessors gave a detailed account of the animal's internal structure, his skull, bones, stomach, etc. Such works, however, were meant for specialists. Popular books, on the other hand, were full of errors and inventions. Nor did they provide information about all animals.

Brehm undertook to tell the general reader about as many animals as possible, about their habits and way of life.

No book of this kind had ever been attempted.

The first volume of *Tierleben (The Life of Animals)* came out in 1863.

The book was not based on Brehm's observations alone. For many years he had been maintaining correspondence with hundreds of hunters, travellers, nature lovers, foresters, fishermen, and zoologists, in a word with all those who could tell him about animals. This enriched his book on the one hand and lowered its authenticity on the other, because many dubious stories and inventions made their way into *The Life of Animals.*

Its first edition contained six volumes. Several years later, a second edition was brought out, which was considerably expanded and supplemented, as well as purged, though not thoroughly, of fables and inventions.

Brehm's books played an enormous role in the development and popularisation of zoology. No wonder they were translated into dozens of languages, and new editions are issued to this day.

Every new edition incorporates new data and excludes what has been proved wrong, and many facts receive a different interpretation. That is as it should be, for science marches ahead. This does not detract from the brilliant accomplishment of Alfred Brehm, a traveller, discoverer, naturalist and writer, who was the first to tell about all the animals which were known in his time.

TO SUM UP THE PREVIOUS CHAPTER AND INTRODUCE THE NEXT ONE

Zoology is the kind of science which must be done collectively. Even if the researcher works alone in a forest or a laboratory, he must be up to date with the work of his colleagues and must be aware of the knowledge attained before him. Otherwise he will be marking time or rediscovering what had already been discovered.

The science of animals developed over millennia. And each new generation of zoologists used the experience of their predecessors, whether they accepted or rejected it.

The previous chapter told you about only a few illustrious names in zoology. But there were thousands run-of-the-mill zoologists besides, and however small the contribution of each, they made possible the appearance of Gesner, Linnaeus, Lamarck, Cuvier, Wallace and Darwin. Thanks to them, mankind came to know the animals of our planet.

Today, over a million species of animals inhabiting our planet have been discovered and described. If you recall, Aristotle described only 60 species of insects. Linnaeus knew 1,929 species of insects. We know today of more than 20,000 species of crustaceans. Aristotle knew only 15 and Linnaeus, 89. We know about 10,000 species of fish, Aristotle knew only 117, and Linnaeus, 250. The same applies to birds, mammals and other animals. The total number of animal species known to Aristotle was 454, to Linnaeus, 4,200, and to modern zoologists, more than a million. This means that over the two thousand years that divided Aristotle from Linnaeus the list of animals only grew ninefold. In the 200 years since Linnaeus, it has grown nearly 300-fold.

The main reason to account for this rapid progress in later centuries is, of course, the growth and development of the science of animals.

It would have taken mankind much longer to get to know about the animals of our planet had not Linnaeus introduced his system. It would have been much more difficult to study animals if we had not had the science of comparative anatomy fathered by Cuvier and the theory of natural selection developed by Darwin. But the more animals people discovered, the harder it was to study them. Even the most knowledgeable zoologist cannot remember more than a small portion of them.

So zoology has been divided into various departments. One of them, arachnology, studies spiders, of which we now know about 35 thousand species. The department that studies insects is called entomology; the department devoted to molluscs, malacology; the science of fishes is called ichthyology; of reptiles, herpetology; of amphibia, batrachiology; of crustaceans, ostracology; of birds, ornithology; and about mammals, mammalogy or teriology. Nor is this all. As a science develops, new departments arise and greater specialisation is called for.

For instance, as long as people did not know very much about spiders, there was no need to assign a special department to them. Then a special department, arachnology, took shape. Ticks also belong to the Arachnida. For a while there was no need to separate them. But when it was discovered that there are many kinds of ticks and that quite a few are carriers of dangerous diseases, a special science emerged studying ticks. It is called acarology.

So a man studying ticks is unquestionably a zoologist, but this is too general a word. To be more exact, we have to call him an arachnologist (since ticks belong with the spiders, the Arachnida). But since he is a specialist in ticks, his proper title is acarologist.

To study one species of animals or another means to observe them in their natural habitat in order to find out what they eat, how they breed and care for their young or, at the very least, to establish what kind of animal it is, whether it is known to zoology or not, how widely distributed it is, where it lives, what its internal structure is, etc. Nor is this all. Beasts, birds, fishes and insects do not live by themselves; they are surrounded by other animals and plants. How do they affect one another, what are their interrelationships? And finally, almost all animals come into some form of contact with Man and modern technology. What is their impact on the animal in question? What are the results of this impact?

These and many other questions have to be answered by zoologists.

The study of animals requires, naturally enough, a knowledge of the laws of animal structure and formation. These aspects are dealt with by morphology, which includes two sciences, anatomy and comparative anatomy. Anatomy studies the internal structure of organisms as such, while comparative anatomy compares the structural features of different groups of animals. This comparison reveals differences and similarities between animals. But to obtain a clear idea of the structure of modern animals, one must know their origins and have an idea about their ancestors. This is the field of palaeontology.

Heredity is studied by the science of genetics, while splanchnology studies animals' internal organs.

There are quite a few more branches of zoology, some very young, such as ecology which studies the lives of animals in relation to the environment, or ethology, which studies the behaviour of animals.

All this comprises zoology, because zoology is the all-round science that deals with animals.

Thanks to the development of zoology and all its departments, the list of known animals grew quickly. People believed that there was not a single spot on Earth which had not been thoroughly studied and where all living creatures had not been catalogued. So, it appeared, the list could be considered closed. But the 20th century proved that our planet and the animals living on it had not been studied nearly as exhaustively as the people of the 19th century believed. So today biologists say cautiously: "We know of so many species to date." This means that many more may come to light tomorrow. And, indeed, new animals are continually being discovered.

WE LIVE ON OUR PLANET AMONG QUESTION MARKS WHICH NATURE HAS PUT GENEROUSLY ALL AROUND US.

Bernard Heuvelmans

3

Man Finds and Discovers

The Story of an Unfinished List

Insects have always been the bane of agriculture. To this day, they destroy millions of tons of vegetables and fruit, cereals, and timber. We pay them the terrific toll of a quarter of the overall harvest. And in earlier times, their share was even bigger, because man had no effective means of fighting the six-legged pests.

To learn to fight the insects man first had to study them.

The Russian Entomological Society was founded in St. Petersburg in 1860. Among its members were all the prominent entomologists of the time. The principal task the Society set itself was finding ways and means of combating harmful insects. A special commission was formed within the Society for this express purpose. But one had to have a good knowledge of insects before seeking ways of combating them. The commission decided to begin by drawing up a list of harmful insects. A large group of entomologists undertook the task, and it was believed they would cope with it easily enough. Yet years went by and the list was still incomplete. The thing was that on top of the mammoth work involved in going through realms of entomological literature (altogether, the commission perused more than 10,000 works in Russian and foreign languages) and in making a detailed study of every insect, each year brought new discoveries and additions to the list.

Work on the list took seventy years, and it was not published until 1932, at which time it included 3,124 species.

But no sooner had the list been published, that additions and amendments were introduced to it; even while it was being printed, a number of new pests were discovered.

More than forty years have passed since then, and many more insects have been included in the list. But still it cannot be considered complete, for each new day brings new discoveries!

Carl Linnaeus described a mere 1,500 species of insects. By the middle of the 19th century, entomologists knew 48,000, and by the end of the century, the figure had grown to half a million species.

Today almost a million species of insects are known. Yet entomologists hold that another million or even a million and a half dwell on this earth of ours and still have not been described. It may very well be that the boldest forecasts will prove erroneous, as was the case with the forecast made by the famous German naturalist Lorenz Oken.

In the 1830s, when science knew some 30,000 species of insects, Oken conjectured that their total number should be twice as large (that is some 60 thousand). Many of his colleagues regarded the conjecture as too bold, especially since great Cuvier had announced that everything on our planet had already been discovered. But a mere hundred years later, the number of butterflies alone reached 80,000. Within the next ten years, another 10 thousand were added to the list which was growing at an average of a thousand species a year.

Here is yet another example. In 1935, 18,000 species of woodcutter beetles were known. And ten years later, the list grew by another five thousand.

To be sure, an insect can hide even inside a human dwelling so that you will never find it, and in the forest the

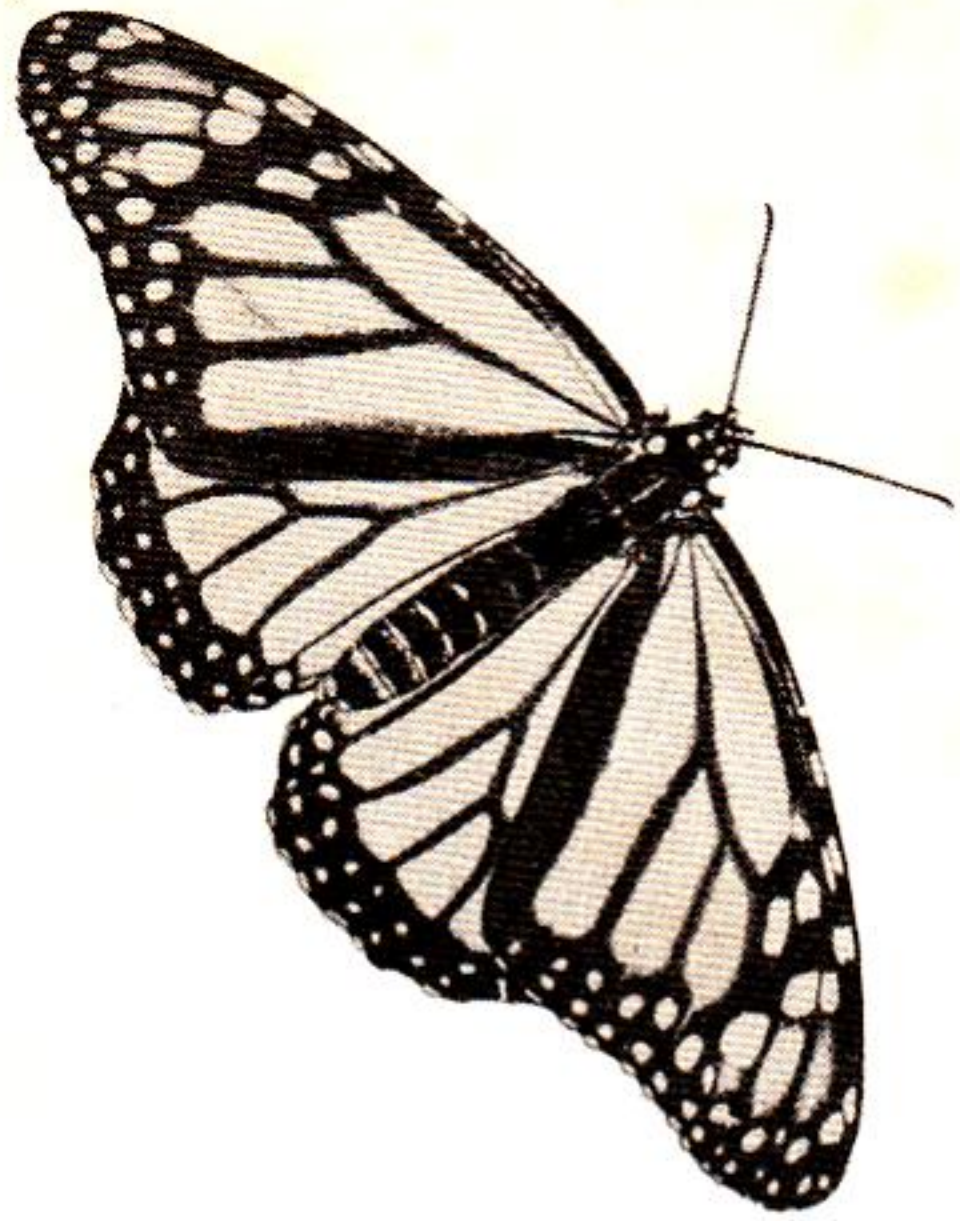
task of finding it becomes more formidable still. You may not see it at all, and if you do, you may not take notice of it, and even if you do, you may fail to realise it is a new species. That is one of the reasons why our information about insects is much less complete than about all other animals and why discoveries are still being made in entomology in far greater numbers than, for instance, in ornithology or mammalogy.

The situation is quite different, of course, with large animals. It cannot be compared to the times of Christopher Columbus or James Cook. The moment Columbus stepped on American soil, dozens of new animals Europeans had never seen before met his gaze. As soon as Cook landed on the Australian coast, he discovered animals so quaint his compatriots long refused to believe in their existence.

But the 20th century put an end to "blank spots" on the map of the earth. Everything, one would think, has been examined, studied, described and photographed. Pessimists believe that today, discoveries are only possible in the realm of insects and small reptiles.

In actual fact, however, over the last fifty years, in the Soviet Union alone, nearly 20 new species of small mammals have been discovered, among them rodents, shrews and bats. And, surely, many more still lurk unknown in the impenetrable forests of South America, Australia, Asia, and Africa.

It has been calculated that even today, there are some 12-14 million square kilometres of virgin, impassable, dangerous forests on earth. The Polish traveller Arkady Fiedler referred to such forests as these when he wrote: "There are only two pleasant days for a man who travels in the jungle.

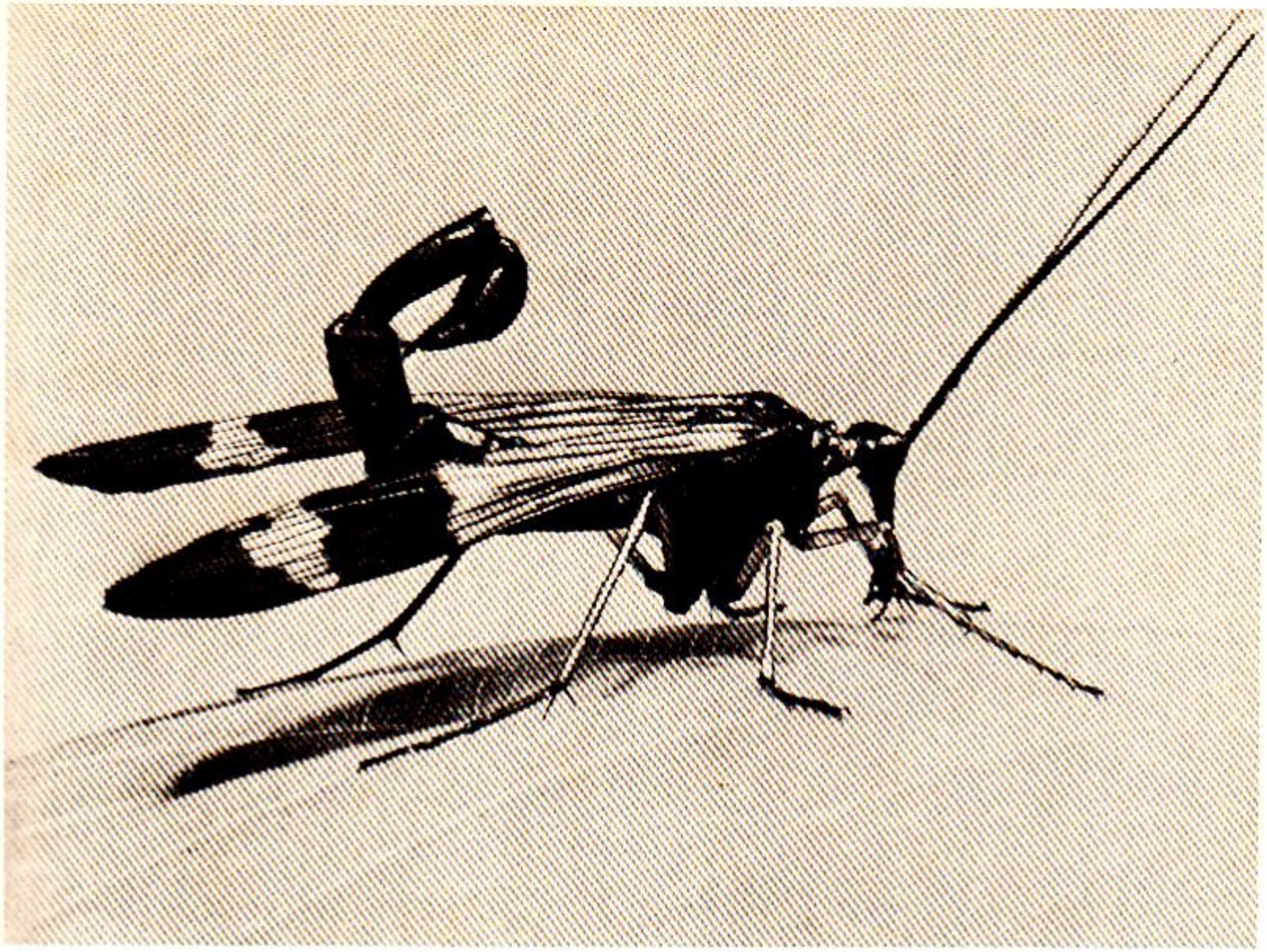


• *Nearly a million species of insects are known to science today. Some entomologists believe that these are only a half of the entire six-legged population of the planet.*

They are the very first day when, blinded by its enchanting magnificence, and majesty, he imagines himself in paradise, and the very last day when, on the verge of insanity, he flees the green hell."

There is yet another vast "blank spot" which occupies two-thirds of the surface of our planet: the seas and oceans. People began to study this "blank spot" only recently and at once discovered an amazing world populated with the most fantastic creatures.

No, the animals of our planet have not yet been studied exhaustively. Proof of this are the thousands of discoveries made every year. Within the last few



There are nearly 20 thousand species of the Ichneumonidae alone.

decades, nearly fifty large animals of which man had no inkling whatever have been discovered, including a species of whale. And that in this 20th century of ours!

But before telling about these discoveries, I should like to define the very notion of discovery.

In 1797 an animal was found in Australia which looked a bit like an otter but had a duck's bill.

Its skin was sent to England where it was studied at the Royal Society. Members of the Society came to the unanimous conclusion that such an animal could not possibly exist and was a fake.

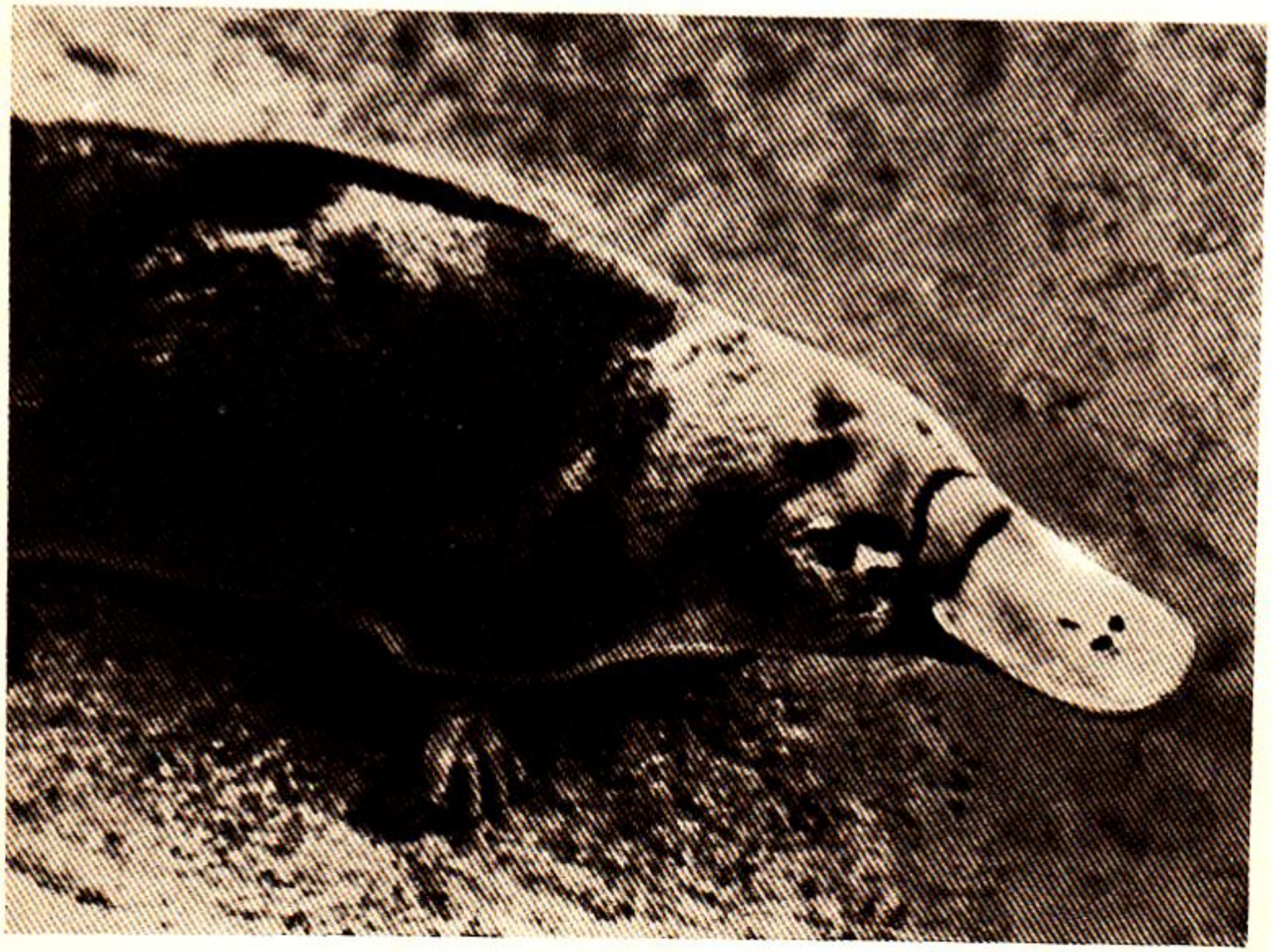
They had ample reason for scepticism. For centuries previously, tales about dragons, mermaids, many-headed serpents and similar monsters were told, and their bodies were even constructed out of parts of different animals. This was just another fake, zoologists decided. Then, several years later, two live duck-billed platypus

were brought to England, sure testimony that the hairy wonder with a duck-bill did in fact exist.

Perhaps the fascination with the duck-billed platypus would have ended then and there and would have been included in the list of animals considered its kin had it not become known that the creature laid eggs. Perhaps it was not a beast with a bill but a bird covered with fur?

The duck-billed platypus might have been placed with the birds had not a new sensation shaken the zoological world: the furry "bird" nursed its young, hatched from eggs, with milk!

A heated dispute broke out. Some zoologists maintained that the creature was a bird and therefore it could not possibly nurse its young with milk, others asserted it was a mammal and, as such, could not possibly lay eggs. The dispute went on for all of fifty years until it was definitely established that both sides were wrong and that the platypus did in fact lay eggs like a bird while at the same time it nursed its young like a mammal.



For a long time zoologists refused to believe in the existence of the platypus. And when they were finally convinced, it took them still longer to decide whether it was an animal or a bird.

Thus the duck-billed platypus was finally "discovered" almost a century after the first information about it reached Europe. The year 1882 is regarded as the year of the animal's discovery, although its skin had been studied by Europeans back in 1797. But Australian settlers had known of the animal much earlier and called it the water mole. And surely the Australian aborigines had known of it for centuries before that. Yet the animal was properly "discovered" and classified in the 19th century, when it was given a place of its own (a special place!) among all the animals known to mankind, for only then was it studied and described and given a proper Latin designation.

In general, all large animals were known to the local population long before zoologists learned about them. But they were considered to have been discovered only after they had been described, given a Latin name, and a place among other animals. This sometimes occurred after the animal was quite familiar to the people living in the locality for thousands of years.

Here is one example. Ancient Egyptians often depicted their gods in the form of animals. Egyptologists "decoded" most of these animals easily enough. Yet the god Set was portrayed as an animal unlike any known to zoologists.

It was only many years later that Egyptologists "decoded" the god Set — after they discovered an animal that had been known to the ancient Egyptians but not to subsequent generations. As a matter of fact, this discovery launched a series of marvellous finds made by zoologists in the 20th century.

The Okapi Makes Zoological History

So this animal was known to ancient Egyptians, but all traces of it were lost over the centuries, and neither its name nor any description of it reached modern times.

Yet European travellers and explorers in Africa occasionally heard from the natives about an animal they called "okapi" and even saw holes dug in the earth to trap these animals. However, not a single one was lucky enough to see the actual animal. Could the okapi be but another legend of which Africa had such a rich stock? But no, gradually, skulls and skins of the animal became available to zoologists, and they were able to recreate the okapi's appearance. It turned out to be a heavily muscular animal up to a metre and a half in height. Its forelegs were longer than its hind legs, it had hooves, and the males had short horns — no longer than a centimetre. The animal was herbivorous.

The okapi had a very beautiful coat — dark-brown in males and nearly black in females and calves. The hair was silky and shiny. But the most amazing thing about the okapi was the colouring of its legs, which were striped black and white, the number of stripes varying even in the same individual.

It was thus established that the animal was not a legend, and finally the Europeans were given a chance to see it with their own eyes. With enormous difficulty, an okapi caught in an African jungle was brought to Europe alive.

But the main discovery — and one which caused a sensation in zoological circles — still lay ahead. The study of the okapi's bones revealed an amazing

LA GIRAFFE

The giraffe was known to zoologists for a very long time. Buffon described it back in the 18th century.

similarity to the remains of an animal which had been found during excavations near Athens. That fossil animal was named, suitably, helladoterium. Could the okapi actually be the helladoterium considered long extinct? It was a tempting proposition, but it soon became evident that the two animals were kin but not identical. It was a pity, but one could not go against facts. Zoologists had no idea that having relinquished one conclusion, they were soon to arrive at another, no less fantastic: the okapi was proved to have yet another, and closer kin than the fossil helladoterium, and, moreover, one that was hale and hearty and not at all extinct. In short, none other than the giraffe!

At first sight, it would appear very odd that the small okapi, not much bigger than a donkey, should be related to the tallest animal in the world.

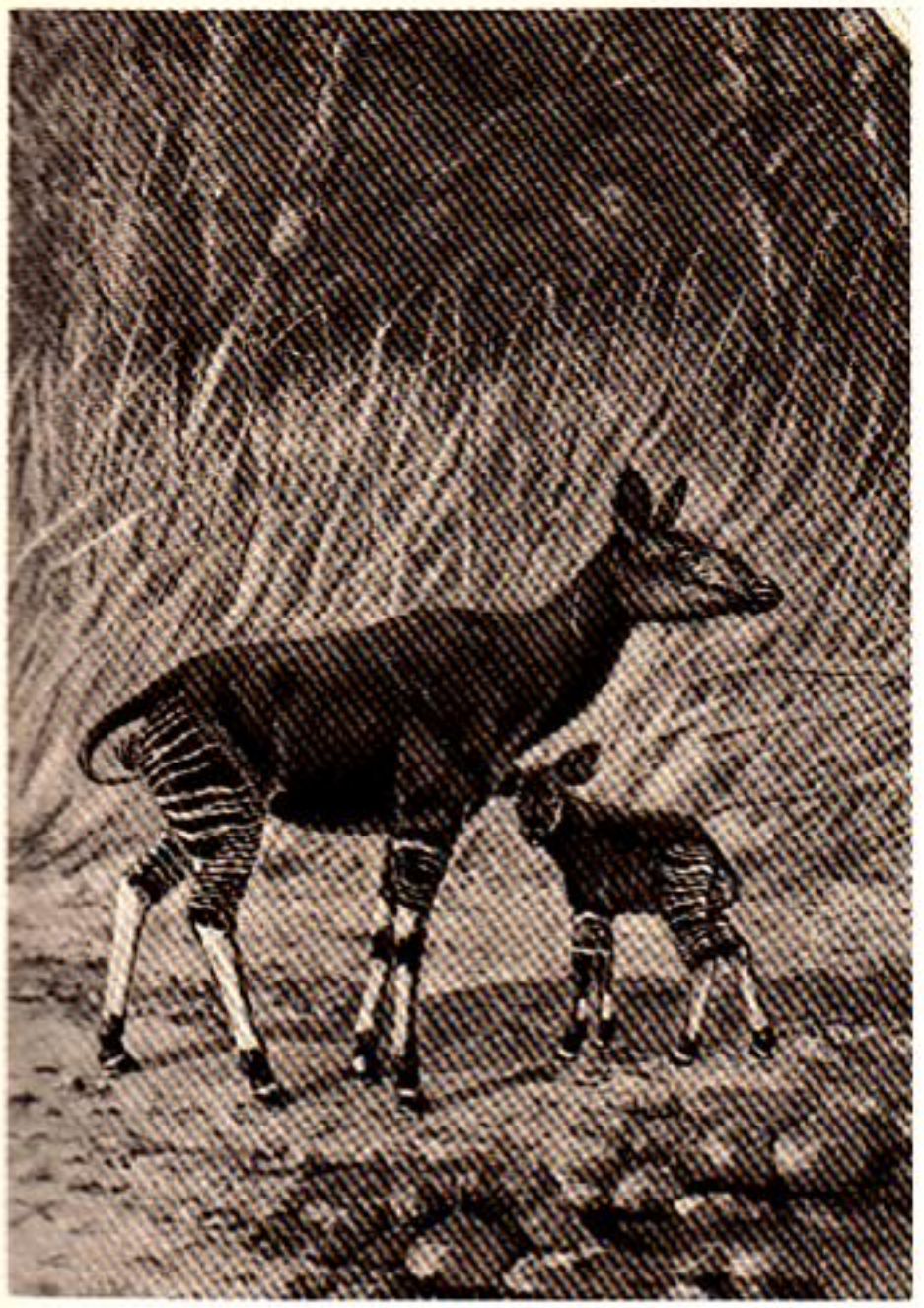
Yet facts indicated that the animals were not merely related, but actually had one and the same forefather, which looked, incidentally, very like the okapi.

But how could this be proved beyond the shadow of a doubt?

Well, if the okapi had been discovered in Carl Linnaeus's time, nobody would have been able to prove this fact, not even Linnaeus himself. As for his predecessors, it would never even have occurred to them to look for a kinship.

Today the kinship of the giraffe and the okapi has been proved thanks to palaeontology and comparative anatomy and thanks to the teaching of Charles Darwin and many other scientific facts which are drawn upon by zoologists. Today it has been possible to prove that the forefather of these two animals looked like the okapi, to explain why this was so, and even to explain why the giraffe bore so little resemblance to its ancestor.

Today scientists know for a fact that tree-like plants appeared on the Earth before grasses. So the forest appeared much earlier than the savannah, to say nothing of grass-covered steppes. Well, if the forest appeared before the steppe, then forest animals also appeared earlier than the steppe ones. That much is obvious. It is equally obvious that the okapi's forefather lived in the forest (where else could it live if the dry land was covered by forest all over?).



But the okapi, the giraffe's close relation, was only discovered in the 20th century.

But gradually, forest-free spaces began to appear, and forest dwellers emerged on these grass-covered expanses. Some of them went to live in the savannah since there were now fewer forests and less living space in them.

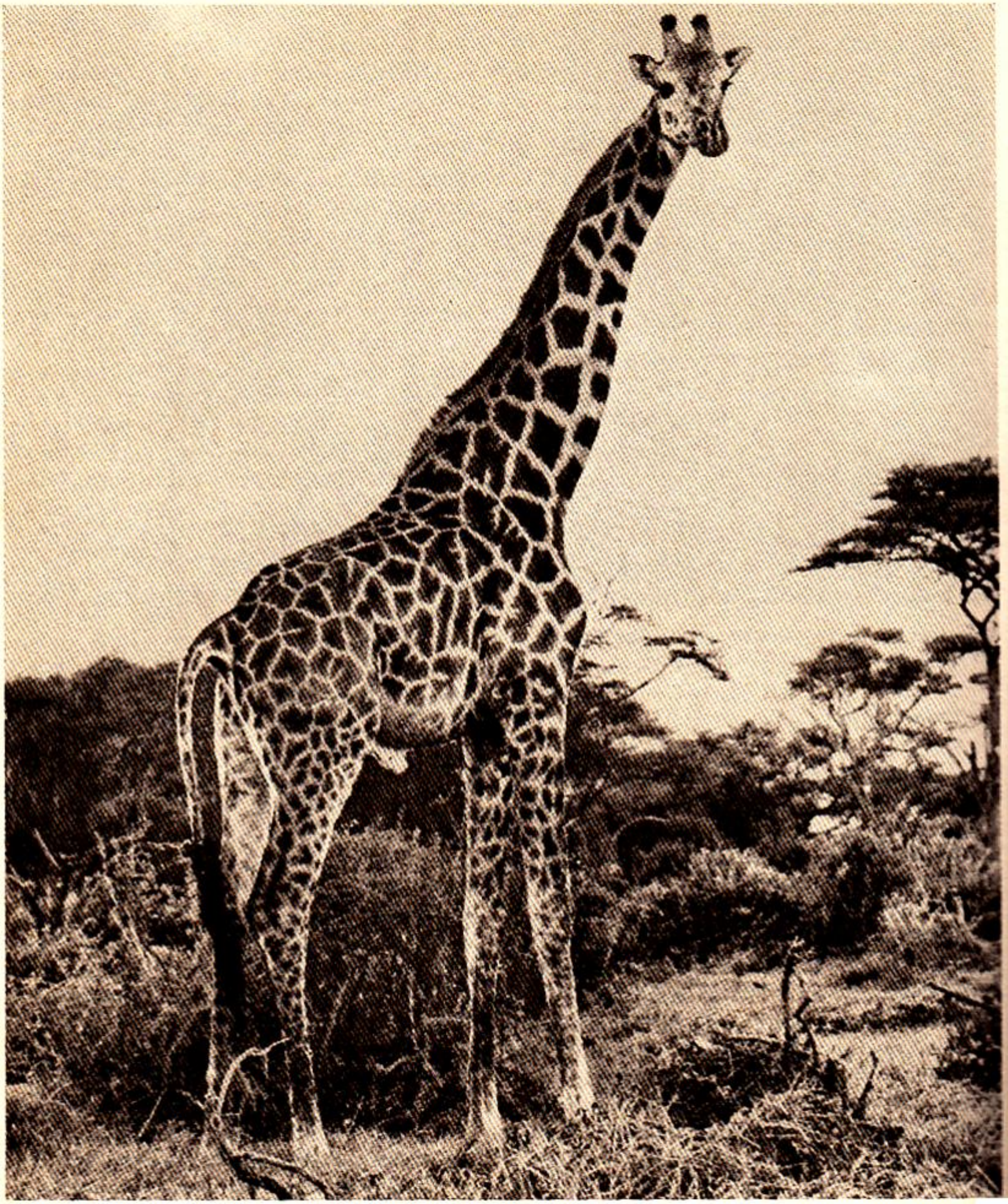
The ancestors of the okapi and the giraffe stayed in the forest for the most part, but some did move — and found life in the savannah very hard. They were adapted to life in the forests where one did not need much height to be able to obtain food. Nor did one need keen eyesight to be able to detect an approaching enemy — the trees blocked the view anyway. Nor did one need fast legs to escape this enemy — you cannot do much running in the forest. What one needed was keen hearing and a capacity for hiding well.

Things were just the opposite in the savannah. The leaves on the trees growing there were high above the earth, eyesight was much more important than hearing, and fast legs more important than the ability to hide.

So the okapi's forest forebears would have perished in the savannah if not for the variety among animals which is found even within one and the same species. Some individuals had longer necks than the others, and some had longer legs. Those with longer legs and necks also had a hard time of it, but easier than their short-legged brothers. The latter were only able to eat the leaves on the lower branches, while the long-necked ones were able to reach higher. On the other hand, the short-legged animal could graze more easily, it would seem, but the grass burned and was trampled down quickly, so they had to move from place to place. And movement was easier for long-legged ones. Also the long-legged ones could make their escape from predators more easily.

Lamarck would have said that the necks and legs of these animals developed due to constant exercise. Yet it could be argued that much as you run, your legs will not grow. Their muscles will be strengthened, that's true, but their length would remain the same. Darwin, on the other hand, had a more feasible explanation.

Those whose legs and necks were shorter became prey to predators sooner or starved. The long-necked and long-legged ones lived longer and left more progeny. The young inherited the features of their parents — long legs and necks. But even in subsequent generations, the length of legs and



Some regard him as clumsy and absurd, others are convinced that he is as handsome as they make them.

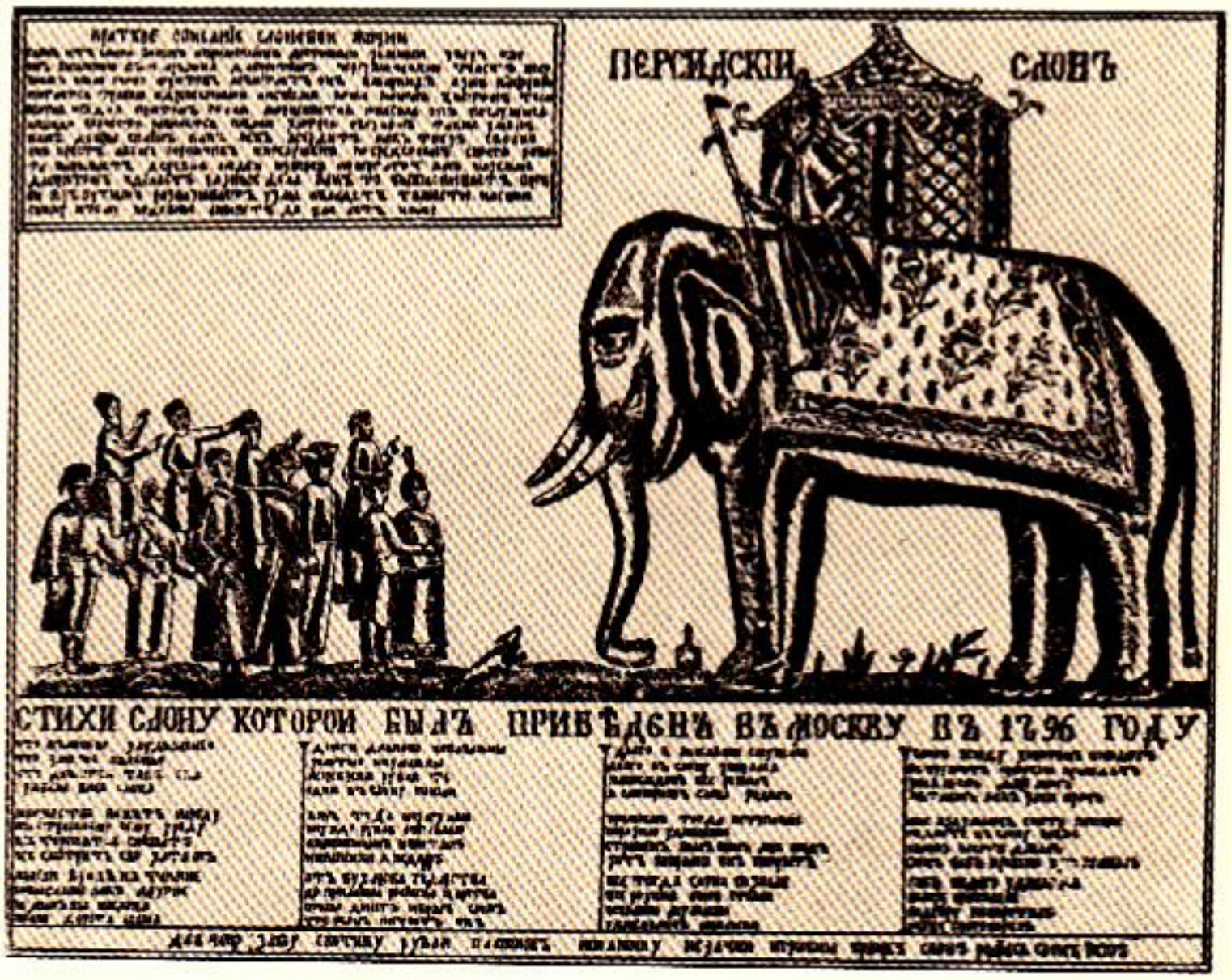
necks varied. And again those who were better equipped lived longer, and those who had shorter legs and necks died sooner.

Thus hundreds and thousands of years passed. In the course of them, innumerable generations of okapis succeeded one another. And in each new generation, those which were better adapted to the new conditions of life, that is, had longer legs and necks, survived. Thus the short okapi gradually grew into the five- or six-metre-tall giraffe, the tallest animal on earth.

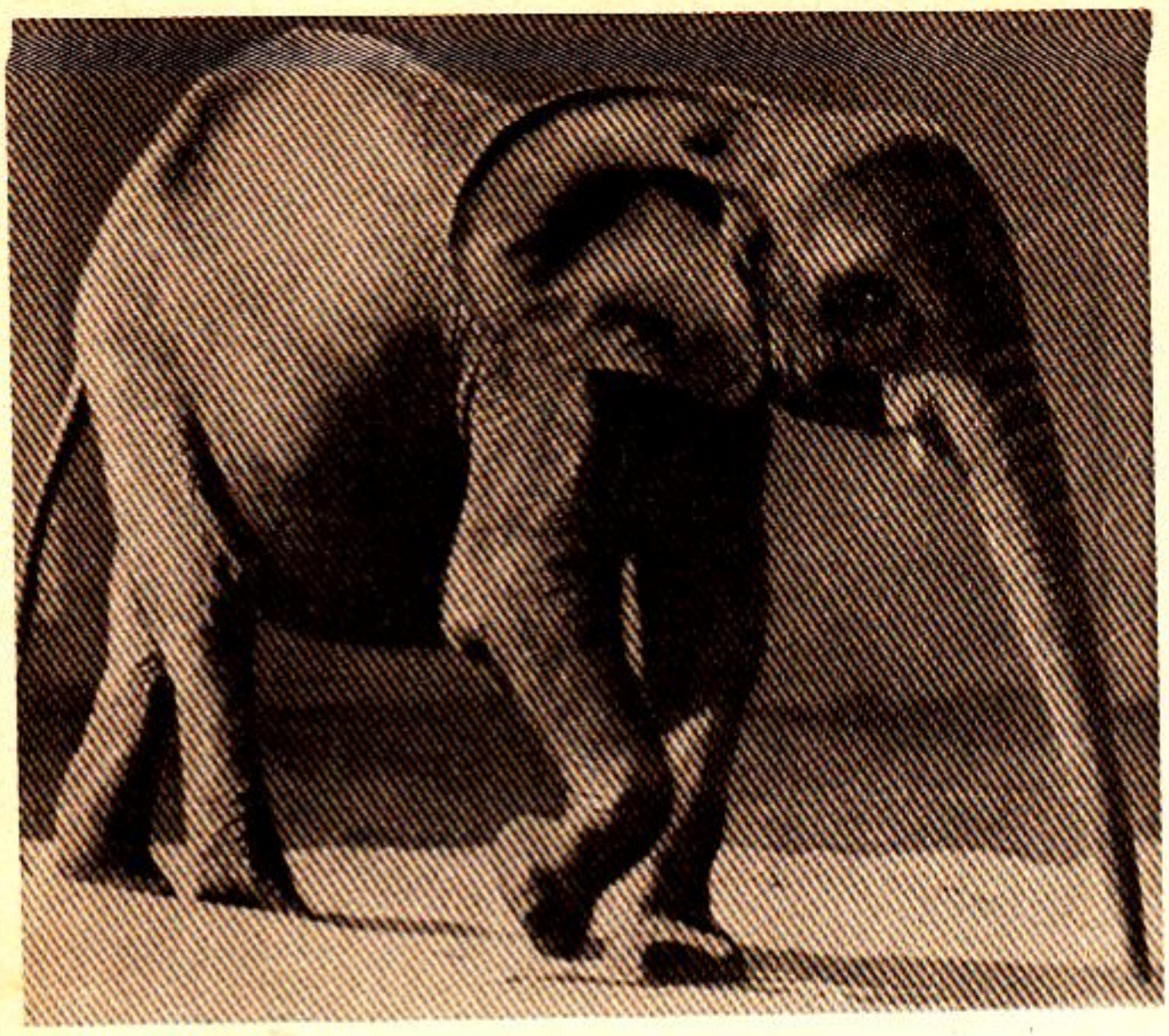
As for those which remained in the forest, they were well adapted to their environment; their conditions of life did not change, and they had no need to grow.

All this, however, was only established later. And then, on the threshold of the present century, zoologists were thrilled to hear about the discovery of a new animal, the okapi. It was probably for this reason that yet another discovery made in the same year of 1900 passed practically unnoticed, although it was significant enough: a new species of elephant, the round-eared elephant, had been found.

Huge African elephants have been known to people for millennia. In hoary antiquity, they were used as draught animals and as "living tanks" (fighting elephants often decided battles). Ivory was also valued greatly in ancient times. And it was perhaps because of their interest in elephant tusks that people noticed even in those distant times that elephants varied greatly. There were among them undersized individuals, whose height was a mere 2.5 metres, whereas the "normal" African elephant is 3.5 and sometimes even 3.75 metres tall. But people did not attach any special significance to the fact, merely rejecting the smaller elephants for the obvious reason



One of the first "popular science" publications to be issued in Russia was a print describing the elephant which had arrived, as a gift, from Persia. It contained verses and a "brief description of an elephant's life" (1796).



The round-eared dwarf-elephant was only discovered in 1900.

that they were weaker, of less use as fighting animals, and gave less ivory, their tusks weighing some 8, or at most 15 kilos, as compared to the 80-kilo tusks of the "normal" elephant. On the other hand, ancient people might not have known of the existence of small elephants at all, since, as distinct from their big cousins, they lived in dense forests that were practically inaccessible.

It is more than likely that the same process of natural selection took place with elephants that did with okapis. Forest dwellers, once they emerged onto the plain, gradually changed in appearance. To be sure, the contrast is not so sharp as in the case of the giraffe, but the elephants did gain in height, and the angle of their tusks changed: the tusks of forest elephants are turned down (this is more convenient for a forest dweller), while steppe elephants (this name was given the orthodox African elephant after the discovery of his forest cousin) have tusks turned forward and up. With forest elephants, the hind part of the rump is higher than with the steppe elephants. There is a difference in colouring as well. And, last but not least, their very way of life altered drastically: steppe elephants are nomadic animals, constantly changing their pastures and forever making long marches. Forest elephants, on the other hand, with an abundant food supply all about, don't like travelling. So the fundamental difference between these two varieties of elephants is in the number of toes: forest elephants have five toes on their forelegs and four toes on their hind legs. Steppe elephants have four toes on their forelegs and only three toes on their hind legs.

In other words, a kinsman was discovered for the elephant family, which formerly had only two large

divisions, the Indian elephant and the African elephant (the long-eared steppe kind). In 1900 they were joined by the round-eared "midget" elephant.

Small though it is by comparison, you cannot really call it a midget: after all, it is 2.5 metres tall. Moreover, increasingly frequent rumours began to reach Europe about the existence of a real dwarf in the elephant family. In 1906 a description of such an elephant was published in a specialised zoological journal, and soon afterwards it arrived in Europe in person and was installed in the Berlin Zoo. This dwarf-elephant, whose height was less than 2 metres, was named Congo.

Soon dwarf-elephants appeared in other zoos as well. This creature might well have stolen the show, had not yet another elephant been discovered just then — the aquatic elephant.

Its discovery cost the life of courageous explorer Captain Franssen. Hearing about the existence of an aquatic elephant, the staunch Belgian swore to catch one alive at all costs. And he did keep his word, bringing with him the hide of the elusive animal called waka-waka by the local people. But, to stalk it, the captain had to spend 36 hours in a swamp, and this proved to be the death of Captain Franssen.

The aquatic elephant (so called because, like the hippopotamus, it lives by the water and never moves far away from it) proved to be even smaller than the dwarf-elephant: a mere metre and a half in height!

So the fifth member of the elephant family had been discovered.

Nor did the matter stop there.

Today zoologists know about 12 kinds of elephants in Africa. They have not yet established which of them are separate species, which are subspecies and which are simply variants of the same species. Perhaps in the process of sorting the elephants out more discoveries will be made. Or some new kinds of elephants might be found. After all, the okapi marked only the beginning of the marvellous discoveries of the 20th century, and we have no means of knowing where the end may be.

The Mammoth Boar, the Black Tapir, the Giant Bull and the Two Discoveries of Hans Schomburgk

Visitors to the Moscow Zoo invariably linger by the strange animal that lives in the run next to the hippo's. The creature is not very big and has a long trunk-like nose. Altogether, it looks like a mixture between a baby elephant and a hippo.

This strange beast is a tapir, or, to be more exact, an American tapir. It was brought to Moscow from South America, where it was initially discovered by zoologists. And when the news arrived that a similar animal had been found on Malay Peninsula, zoologists refused to believe it at first. How could it be that two similar animals should live on two continents separated by thousands of miles of ocean? Not long before, the great Cuvier had declared that there was little hope of discovering any new species of quadrupeds. And here was his favourite pupil Diard sending him this incredible piece of news.

Yet Diard knew what he was talking, or writing, about. The animal he saw was an unmistakable tapir, though it differed from its American cousin in height, build and, particularly, colouring. The American tapir is black or

dark brown, and its Malayan kinsman has a huge white spot on its back.

Diard wrote to his teacher that he was amazed to note that such a large animal had escaped the notice of science. Especially since, as he now recalled, he had seen the head of this animal in a museum in his home country. Indeed it was strange that an animal well known in the East for many centuries before Diard (it is mentioned in the treatises of Oriental scholars under the name *mieh*) should have remained completely unknown to Europeans. Moreover, zoologists persisted in their doubts even after the existence of the new species — *Tapirus indicus* — was proved beyond all doubt, so used were they to the idea that the tapir was an American animal.

As a matter of fact, more surprises were in store for them as regards the tapir. Before the zoologists had grown accustomed to the idea of Malayan tapirs, news came from the island of Sumatra — there were tapirs there as well, and they were black all over.

Another species?

Possibly.

Is this the last tapir which will be found?

Who knows?

In the early 19th century, Diard was surprised that the zoologists should have overlooked such a large animal as tapir living in Asia. What would he have said had he been told that both his contemporary zoologists — and those who lived decades later — overlooked a land animal which is the world's second largest after the elephant? This animal weighed nearly two tons, was more than 2 metres tall, nearly 5 metres long, and had, in addition, a horn 1 metre 60 centimetres in length. Yes, a horn, for the animal in question was none other than the Sudanese white rhinoceros.

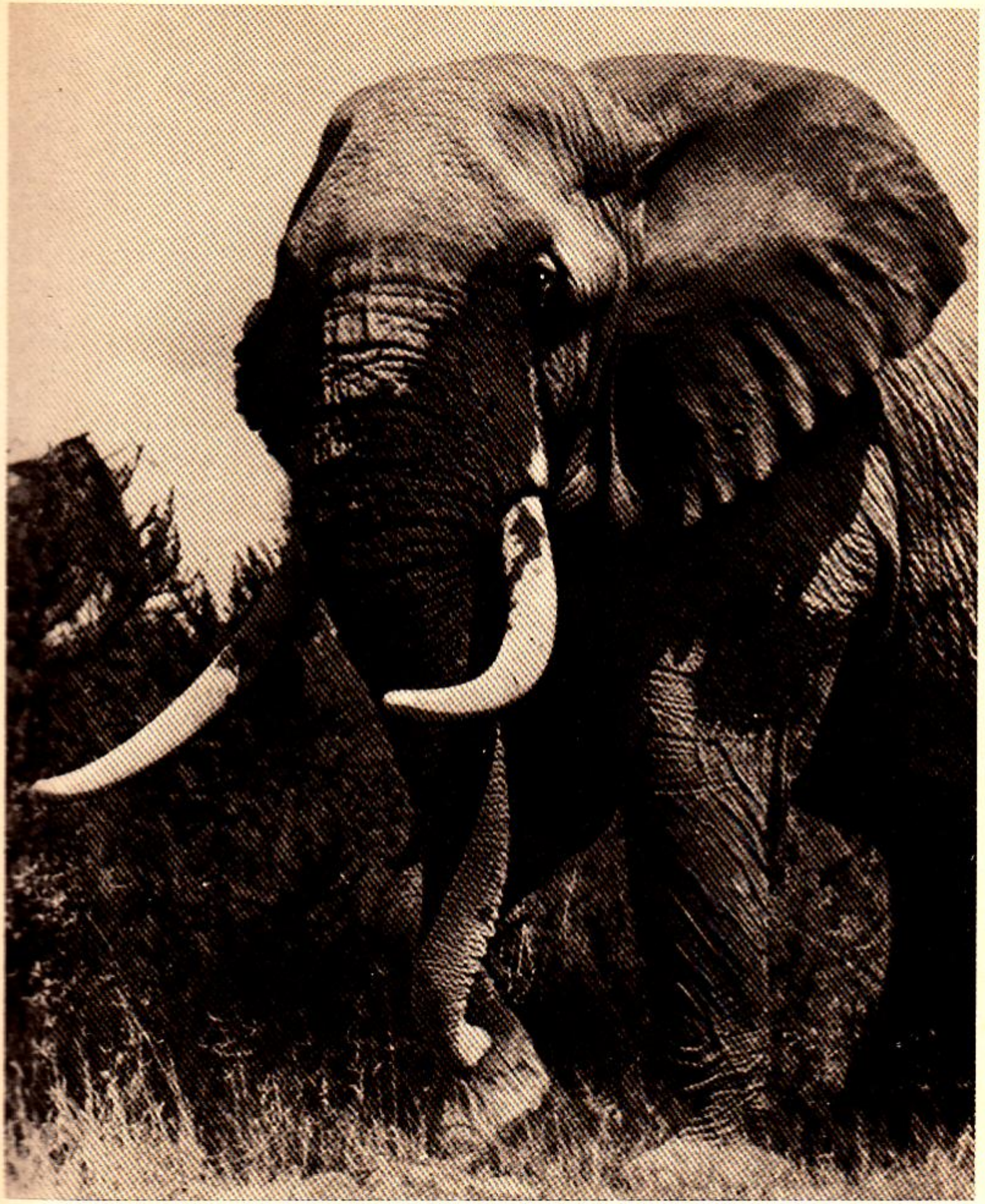
This name, however, was only given it much later. Back in 1900, when an explorer brought to Europe the huge skull of a rhinoceros, zoologists were nonplussed; to be sure, white rhinoceroses were known to science, but, in the first place, they were not expected to be so large, and, in the second, they lived not in the lower reaches of the Nile but in the South of Africa, some 3 thousand kilometres from the place where the skull had been obtained. Nor was this a fossil skull, a fact ascertained easily enough.

Before long, more skulls of giant rhinoceroses were brought to Europe. There could no longer be any doubts as to its existence, and so the rhinoceros was given an official Latin designation and placed on the list of living animals.

All that remained was to catch such a rhinoceros. And this proved to be practically impossible. Fifty years passed before Europeans were able to see live giant rhinoceroses with their own eyes; only in 1950 were two young white rhinoceroses brought to Europe and placed in the Antwerp Zoo.

The Sudanese white rhinoceros is indeed a champion for size among its brethren. Another champion, this time among the boars, was discovered in 1904 in the forests of Uganda. The local population lives in mortal fear of this monstrous boar, which is 2.5 metres long and 1 metre 20 centimetres tall. It is armed with fearsome tusks and has a savage disposition.

Several years before the Nazis occupied Paris, an extremely rare animal was brought to the French capital. During the war, the animal perished and its skin disappeared without a trace. Several years later, another such animal



And this giant was recruited into man's service many thousands of years ago.

was obtained in the Cambodian jungle by some zoological enthusiasts at the cost of supreme effort. Its hide and bones were brought to the United States and thoroughly studied. They are now preserved at Harvard University as testimony that this rare animal actually exists. But it has proved impossible so far to catch it alive.

The animal in question is the giant bull, *Bibos sauveli*, as it was initially called, later to be renamed *Novibibos*. And it proved to represent not only a new species but even a new genus of hoofed animals.

It all began with horns which Achille Urbain, director of a French zoo, saw when travelling about Indo-China in the house of the local vet R. Sauvel. A specialist in the ungulates, he at once established that the horns belonged to an animal unknown to science. Also, he remembered stories he had heard from the local people about a huge bull that lived in the jungle. Soon Urbain, with Sauvel's help, caught a bullock of the species and brought it to Europe. It was this bull that died during the occupation of Paris by the Nazis. However, Urbain and his colleagues had had time to study the animal, which was unlike any of the known wild bulls. The study of the bones and hide later conducted in America confirmed that the bull was not only a new species but also a new genus of hoofed animals. The only mistake which had been made about it was the name, which, in translation, means "a grey bull". The local people who gave the animal this name had indeed seen grey animals in the herds. But they had no means of knowing that these herds consisted mainly of cows and young animals, while the bulls, which were dull black in colour, lived separately and were much harder to observe.

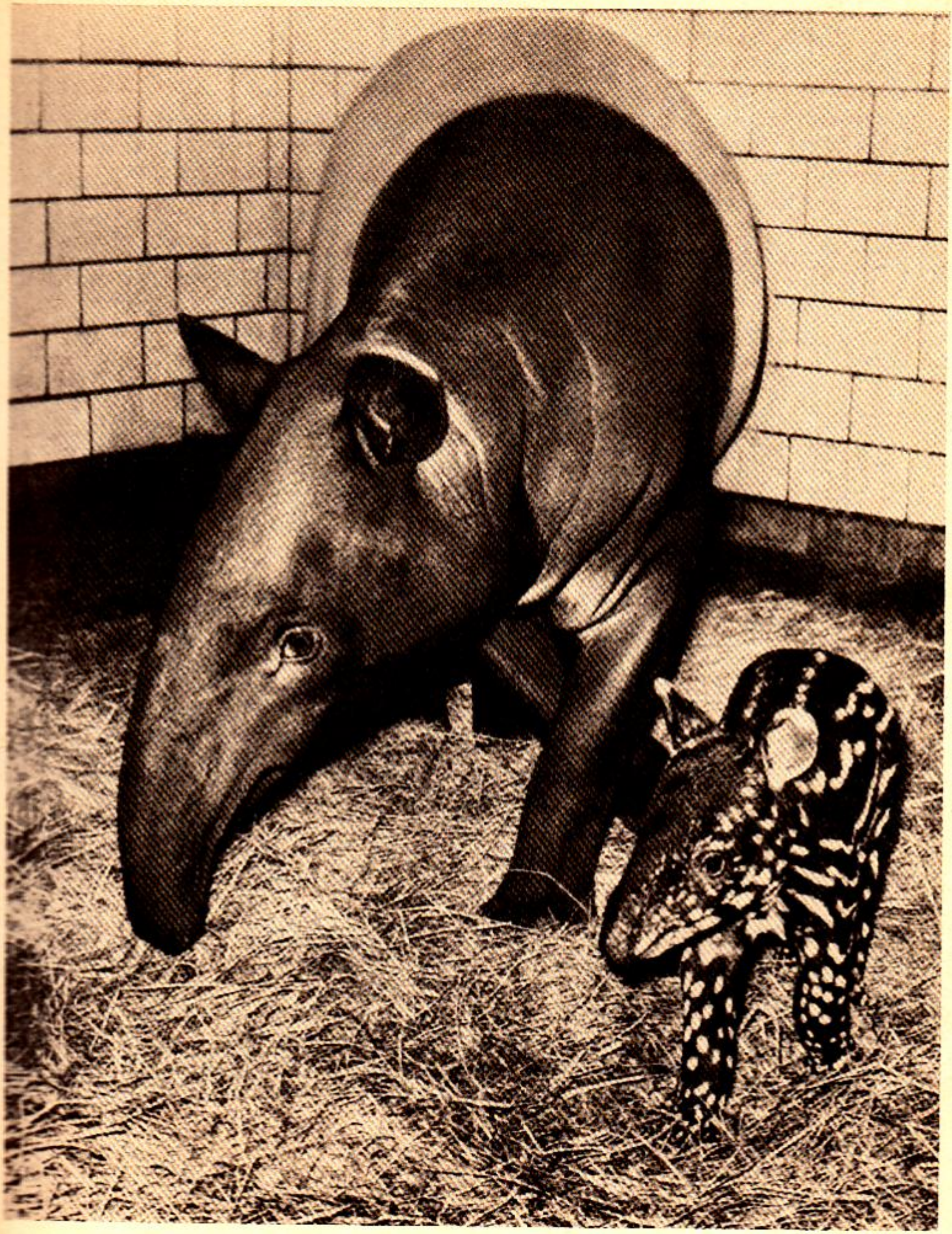
So Urbain discovered for science a giant bull, which was well known to the local population. The famous German traveller and naturalist Hans Schomburgk discovered a dwarf-hippopotamus, also an animal well known to the local inhabitants.

When Schomburgk arrived in Liberia in search of this animal, he was armed with a large stock of legends pertaining to it and an even greater stock of sceptical pronouncements made by European zoologists on the subject. Although they had seen the animal's skull and bones, they persisted in doubting its existence, maintaining that the bones might have belonged to undersized individuals of the ordinary species. The one person who had complete faith in the existence of the dwarf-hippo was the German Karl Hagenbeck, who traded in wild animals and organised zoos. It was he who commissioned his compatriot Hans Schomburgk to go to Africa specifically in search of dwarf-hippopotamuses. And Schomburgk accepted the commission because he, too, was convinced that the animal did exist.

During this journey, Schomburgk ran into a herd of dwarf-elephants and sent the report to Europe. It was in this way that dwarf-elephants were discovered.

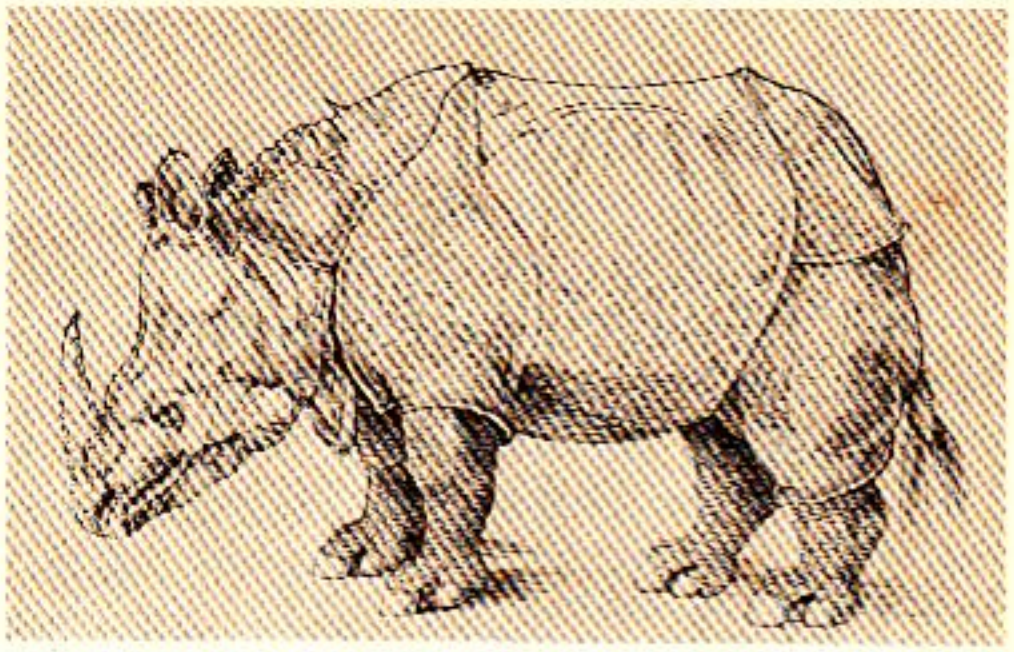
Schomburgk told about his search for the dwarf-hippopotamus and its eventual capture in his book *Pulsebeat of the Wilderness*.

He told about the many difficulties he faced in the Liberian jungle, not least of which was convincing the local inhabitants to accompany him on the hunt for the small hippo, or, as the African tribes variously called the animal, the *nigbwe* or *mwe-mwe*. Yes,



The Malayan tapir. Has he any more kinsmen unknown to men? Who knows?

Rhinoceroses.



This is how Dürer portrayed a rhinoceros in the 16th century.

the local people knew about the small hippo, but the idea of catching one seemed so preposterous that they simply refused to discuss it. In their view, the *nigbwe* was the most ferocious animal in existence, and they shuddered at the mere thought of meeting up with one, to say nothing of capturing the beast.

In the end, Schomburgk did prevail on some native hunters to go with him. This first time they did not succeed in catching the small hippo, but they saw one. So the animal did exist after all!

The rainy season which set in shortly afterwards forced Schomburgk to discontinue his search for the dwarf-hippo. But in December 1911 he was back.

Two years later, he returned to Europe with six live hippos, each half the size of its "normal" cousin and weighing just one tenth of the "normal" weight. The dwarf-hippo was found to have much longer legs than the ordinary hippopotamus, and so in moments of danger, it sought refuge in the forest rather than diving into water. Generally, the dwarf-hippo spent

most of its time in the jungle, although it was just as fond of bathing and lolling in the swamp as its big cousin. When dry, it acquired a reddish-brown tinge — because of the droplets of reddish sweat which stood out on its skin.

Actually Schomburgk discovered the animal not only for the Europeans but also for the local natives.

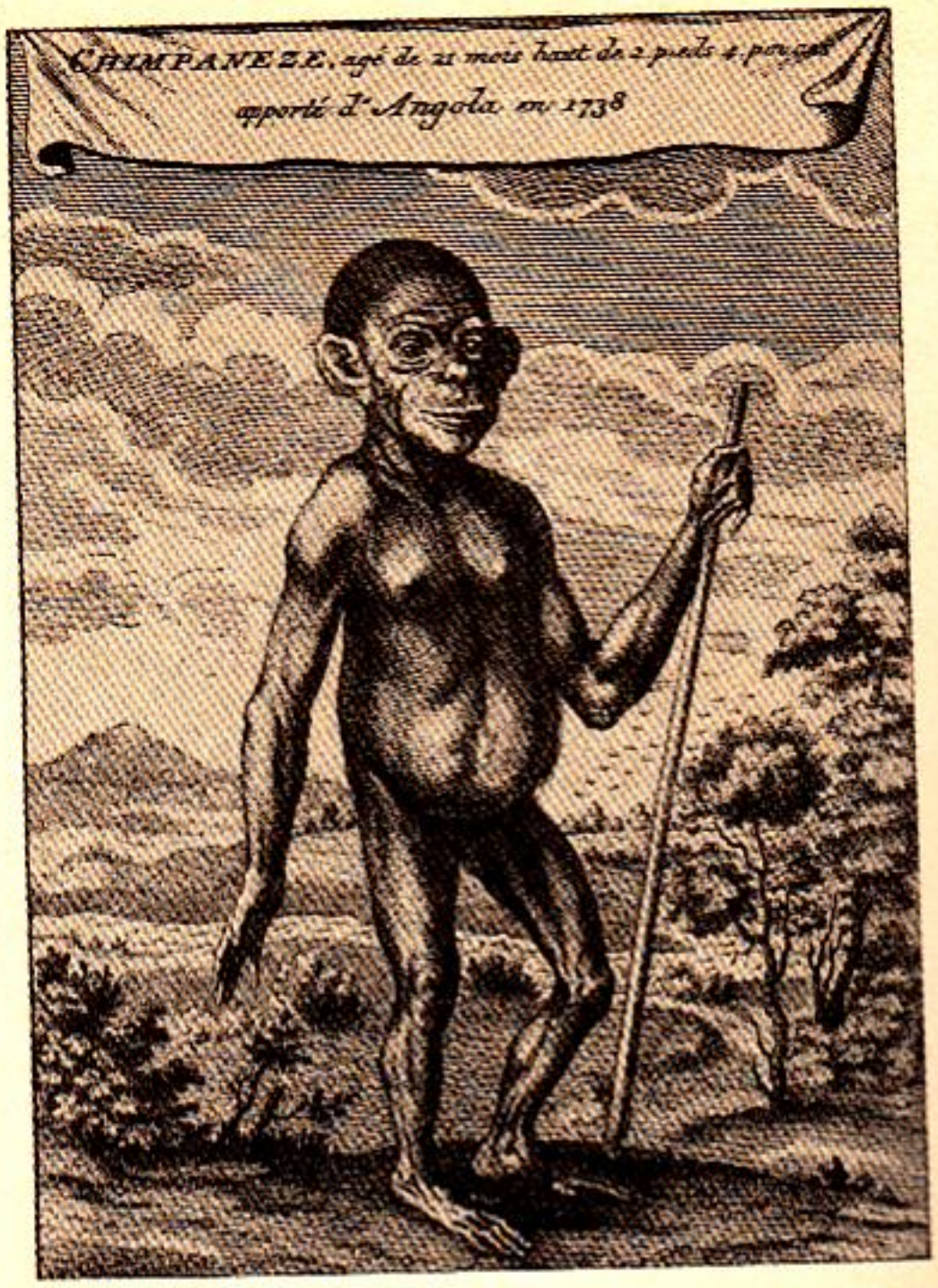
When, in February 1913, he was notified that a dwarf-hippopotamus had finally got caught in one of his pits, it cost him a lot of effort to convince the local hunters to even approach the trap. In the end, they did walk up to it timorously, only to find the captive in the most peaceable of moods. He was munching roots and regarded his enemies with utmost good nature.

Soon, five more dwarf-hippos were captured. The three young ones were amazingly docile and even accepted food practically from people's hands. The old male was very dignified and disapproved of such familiarity, but still, he evinced no aggressiveness whatsoever. Only the female was liable to bite.

Thus the Africans' eyes were opened to the amiable disposition of these animals, regarded over the centuries as most deadly and fearsome.

More "Kinsmen" Are Discovered

A German officer, Captain Oscar von Beringe, was travelling in the German colonies in Africa. It was not a pleasure trip — his mission was to inspire the chiefs of local tribes with the idea of the supremacy and invincibility of the German Empire. Captain von Beringe was a disciplined officer and



A chimpanzee as visualised by an 18th-century artist. The drawing is dated 1738.

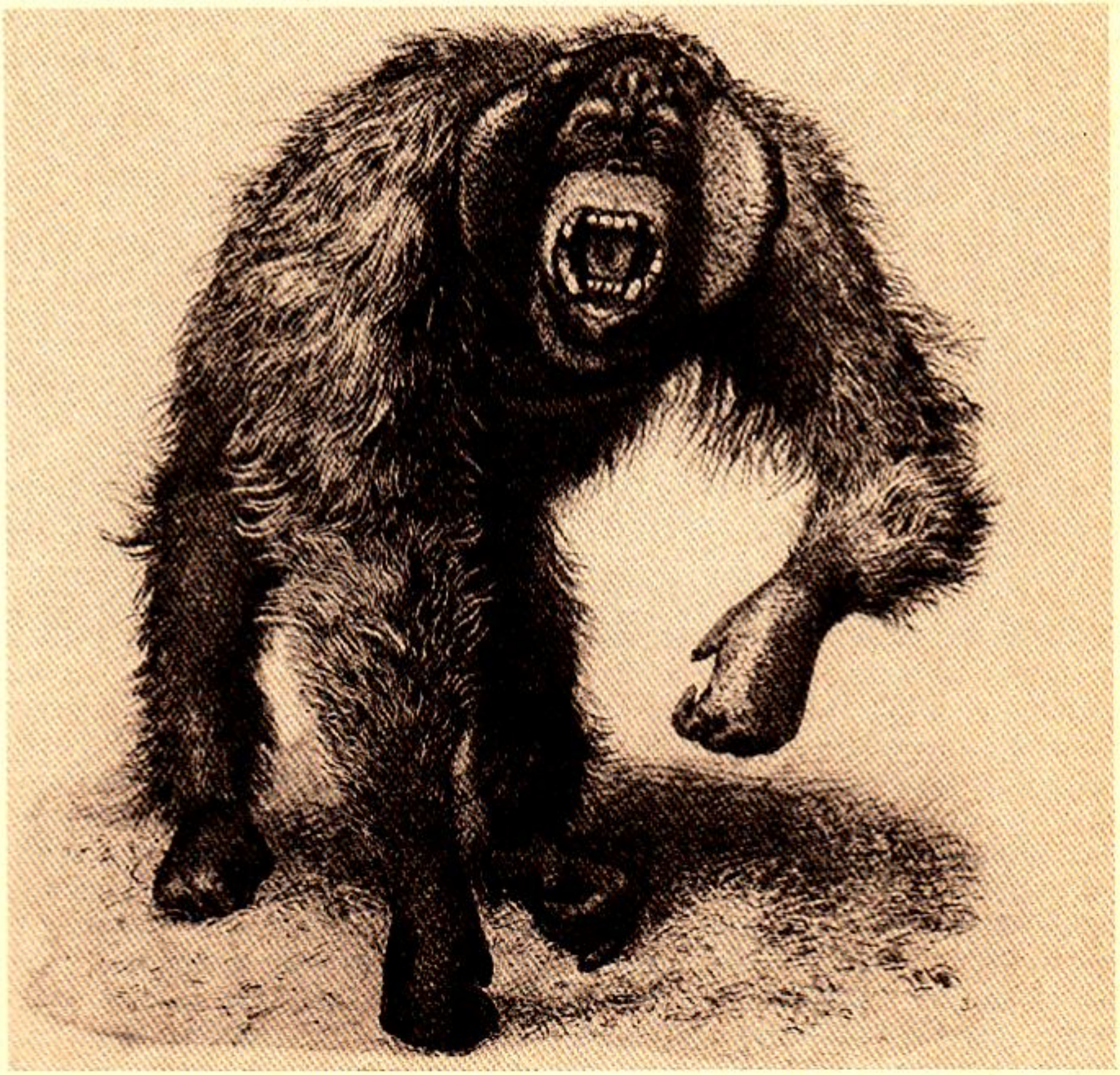
did not shirk his duties. In order to fulfill his assignment, he made his way through the all but impassable jungle and mountains of Ruanda-Urundi. It is hard to tell whether he was successful in his political mission. Even if he were, posterity would hardly have remembered his name on the strength of that alone. But to give the captain his due, he was not only a zealous servant of the Kaiser but also an inquisitive man.

...It happened on 17th October 1902. That day, the captain and his companion intended to climb Mount Sabinio. Pitching camp at an altitude of some 3,000 metres, they saw a herd

of unusual-looking apes, fired and killed two of them. The animals fell into a gorge, and again, to give the two Germans their due, they desisted from killing more animals, preferring to spend five hours hauling one of the apes out of the gorge.

Von Beringe obviously had a fair knowledge of apes, for in his report he wrote: "Unfortunately, I have been unable to determine the species of the animal. I have never seen chimpanzees of this size, and gorillas do not occur in this region."

If they were neither chimpanzees nor gorillas, what were the apes? Nobody seemed to be able to solve the puzzle. And small wonder. The thing is that the "relationship" between men and apes have always been of a very curious order. People knew for a long time about the existence of apes but had little accurate information about them. The Africans who lived in the tropical jungle and had an opportunity to observe them in the wild were convinced that they were also people, and if they did not speak, it was only be-



And this is what he really looks like.

cause they were afraid that if they did (and they could!) they would be made to work.

The Arabs believed that the ape was the incarnation of the devil, while the Egyptians, Hindus and Malayans deified apes. Their pictures are found on many objects which reached us from ancient times. They are also mentioned in literary works and scholarly manuscripts of the antiquity.

Back in 470 B. C., Hanno, a seafarer from Carthage who reached the shores of West Africa, told about the hairy "people" he met in the foothills of the Sierra-Leone Mountains, who threw stones at their party. The Carthaginians caught three of these animals — the natives called them "garillai". Pliny recounts that more than three centuries later (in 146 B. C.) when the Romans defeated Carthage and overran the city, they found, among the ruins of a temple, two skins of these human-like animals.

Great interest in anthropoid apes was evinced in Ancient Greece and Rome, but their scholars could not study these animals, since none lived on their territory and bringing them over involved formidable difficulties. In the Middle Ages the attitude to apes, as to many other animals, underwent a radical change. The church raised additional difficulties in the way of studying them, distorting even the little knowledge people did have. (Suffice it to say that until quite recently, there was an official ban in some states of the USA on the teaching of Darwin's theory of the origin of man. In 1925, a teacher was actually put on trial for acquainting his pupils with Darwin's theory and asserting man's kinship with anthropoid apes.)

So the broad public in Europe had its first glimpse of live monkeys only in 1792 when Europe's first zoo was set up in Paris on the decision of the National Convention, the legislative assembly during the French Revolution. Curiously enough, a monkey was brought to Russia earlier than that, in 1744. It was kept in the Izmailovo menagerie, where, according to a relevant document, it "fed on wheat flour, *barankis* and butter, costing 5 rubles 80 kopecks a month". But the monkeys displayed in Paris and the one in Russia were all of a lower order. Anthropoid apes did not appear in Europe until 1830 when an orangutan was brought to the London Zoo. In 1836 the London Zoo acquired a chimpanzee. The first gorilla came to Europe in 1855, and even then no one knew — not even zoologists — that this ape was none other than the gorilla.

Towards the end of last century, monkeys and apes had been studied fairly well, but mostly in captivity. People still knew very little about their life in the wild.

Information about monkeys was mostly supplied by travellers, and these did not hesitate to embellish and invent, while many were not above boasting.

Moreover, they often gave descriptions of animals, including monkeys and apes, they had heard from other people and would pass off fantastic tales told by the natives as the truth.

So even when they brought "material evidence" along, such as skulls of huge apes, zoologists remained sceptical, believing these to belong to animals long extinct.

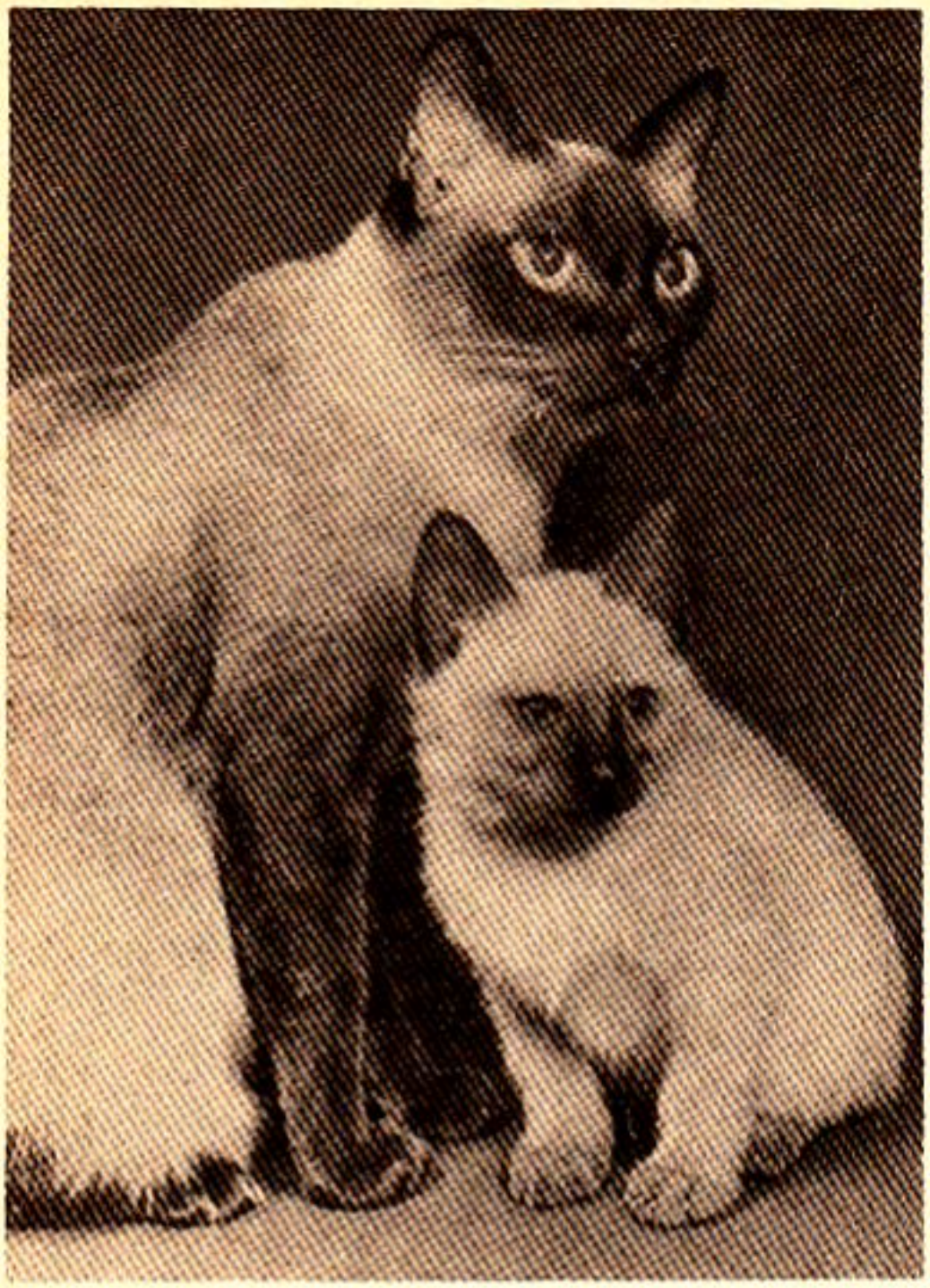
For a long time, zoologists refused to acknowledge the existence of gorillas. After all, until the mid-19th century not a single European had

The favourite dish.

even seen a gorilla, and the first gorillas to be seen were mistaken for large chimpanzees.

In the end, of course, gorillas were acknowledged by science, and the region of their habitat, West Africa, was established as well.

It was this area that Captain von Beringe had in mind when he said that gorillas did not live in the region of Lake Kivu, which lay at a distance of several thousand kilometres from gorillas' known habitats. Beringe can be forgiven his doubts when even major zoologists refused to believe that gorillas lived in the vicinity of the



They are called Siamese cats, though they have nothing to do with Siam.

lake. And this despite the information contained in the book by the traveller John Speke, *Journal of the Discovery of the Source of the Nile*, about "monsters" unable to talk but otherwise bearing a great resemblance to humans of which he had heard from the local people.

Nor did zoologists believe the report of another traveller about the discovery of a skeleton of a huge ape in 1898.

But Beringe brought more than stories and legends, he brought with him to Europe the skeleton of the ape he had killed. And so in 1903 Paul Matschie published a description of a mountain gorilla (as distinct from coastal gorilla living in the forests along the coast of the Gulf of Guinea). The mountain gorilla was larger and more powerfully built, two metres tall, the weight of large males reaching 300-350 kilograms.

Von Beringe brought no particular glory to the Second Reich but earned fame for himself, for the mountain gorilla described by Matschie was named after him.

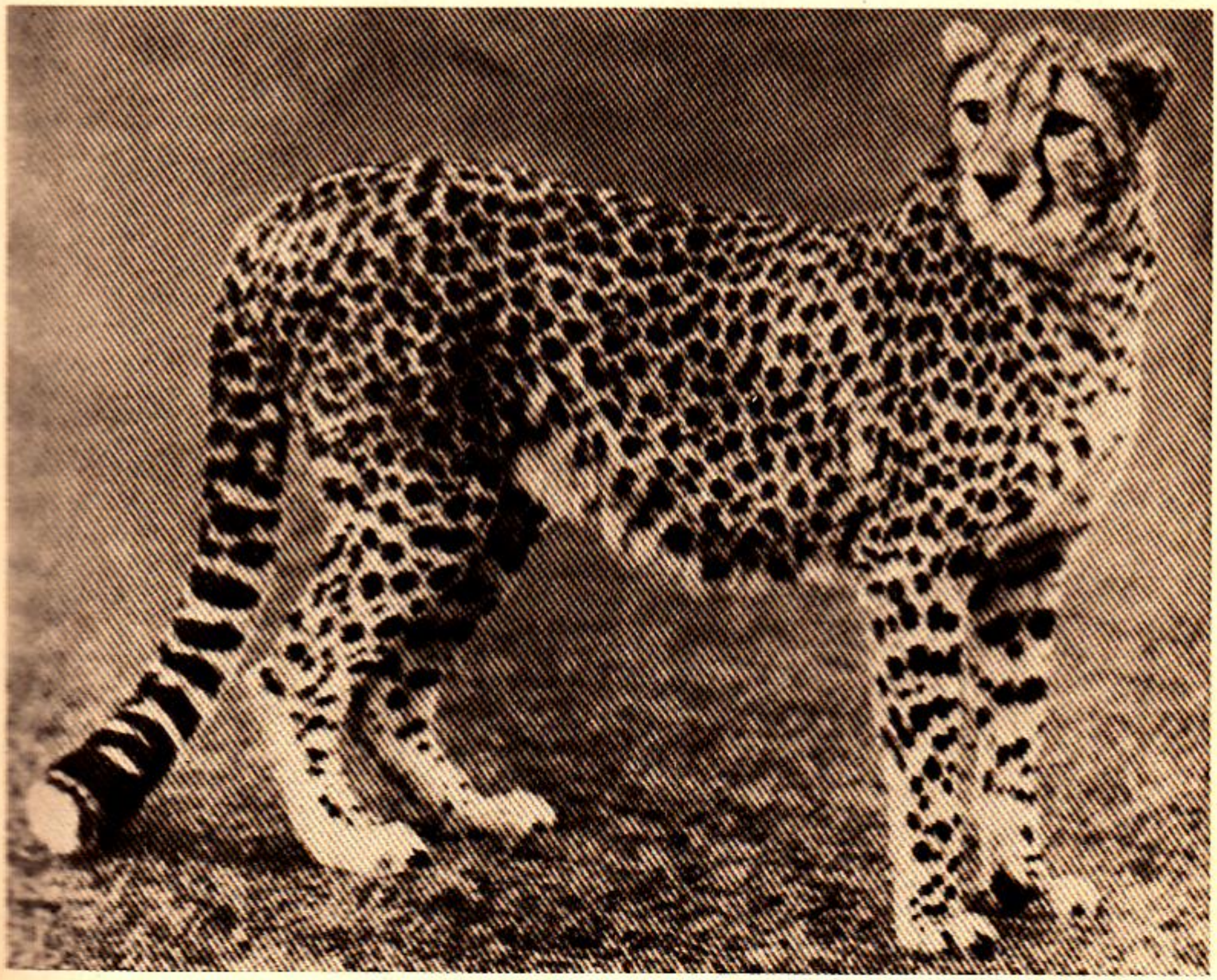
It is hard to say whether Captain von Beringe was proud of this honour. But three decades later, when the Nazis came to power in Germany, many sneered at this academic distinction of their brother officer, as they did at science in general, except for those branches of it which helped Germany arm itself and assert the superiority of the Aryan race.

Because of this attitude, another remarkable discovery was held up for many years. In 1929, Ernst Schwarz, while studying skeletons of apes living in the Congo by the specimens preserved in a Belgian museum, found some bones belonging to very small apes, smaller than the chimpanzee. He decided this was a new species, and it came to be known in science as the Schwarz-pygmy-chimpanzee. Soon two live pygmy-chimpanzees arrived in Europe from the Congo jungle — one was placed in the Paris Zoo, and another in Anwerp Zoo.

While zoologists were making up their minds whether this was just a subspecies or a new species, the Second World War was unleashed by the Nazi Germany. And few zoologists had an inkling of the fact that several pygmy-chimpanzees lived in the menagerie

of a small German town not far from Munich. And certainly nobody, except two or three people who worked at the menagerie and the apes' keeper, knew what amazing creatures they were. Not only were they outwardly different from the larger chimpanzees, being only half the size and weight, but they had a very different disposition — peaceable and friendly (large chimpanzees are often morose and irritable). They "talked" to each other differently and even fought differently: they never bit or scratched but only exchanged cuffs, and that very seldom, for they were not quarrelsome. These amiable, lovable monkeys all died in 1944 during an air raid, not from bombs but from fear. Certainly they were timorous, but could there have been another reason? Could their nervous system and mentality have been more sensitive than that of other apes?

Anyway, the war was drawing to a close, the Third Reich was splitting



The cheetah is considered to be the fastest animal on Earth.

at the seams, and Germany had no time for pygmy-chimpanzees. Only ten years later, in 1954, did two German zoologists publish a very interesting paper on the subject.

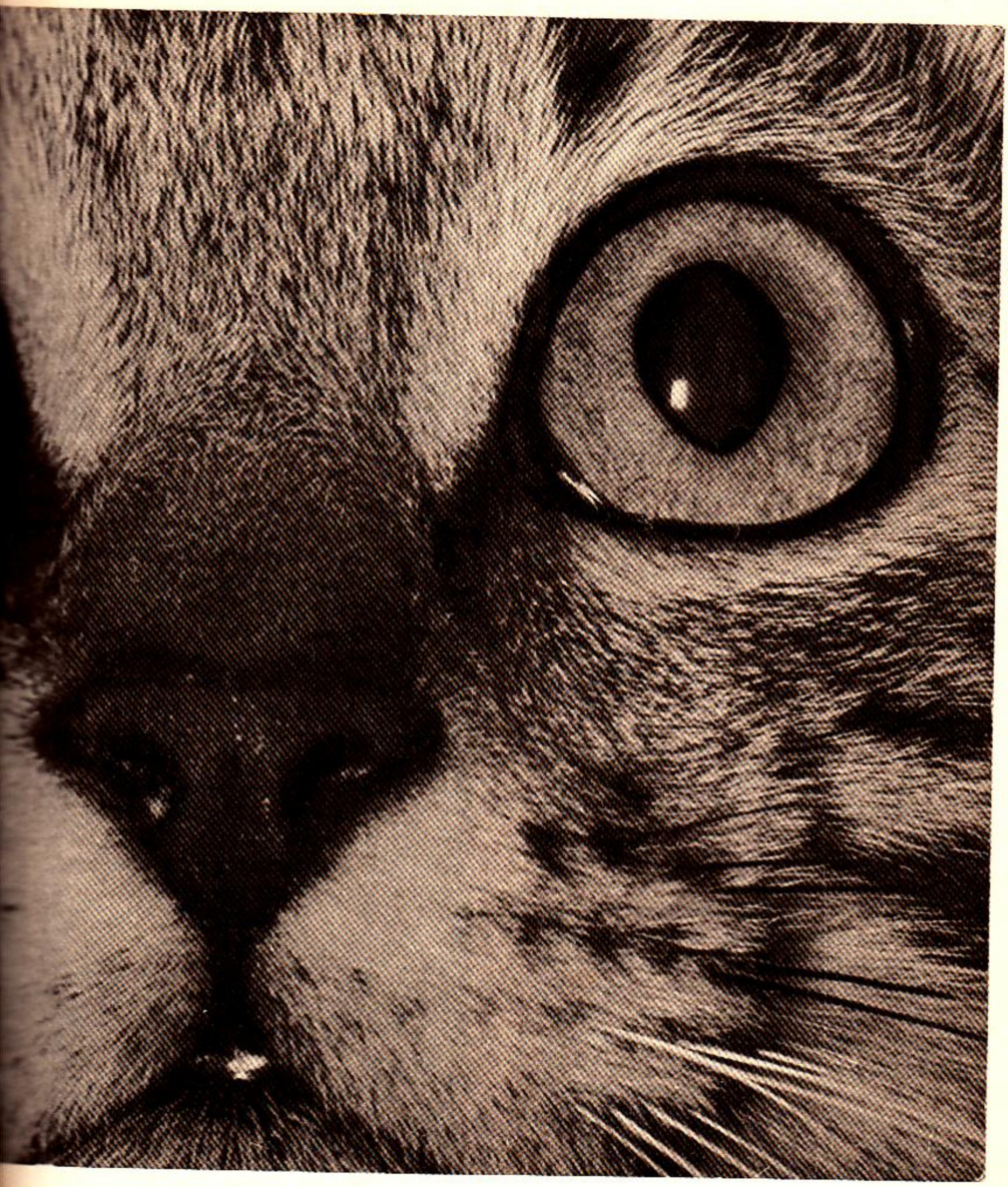
Previously it had been held that there were three species of anthropoid apes — the chimpanzee, the gorilla and the orangutan. The authors of the paper argued that there was also a fourth, the one Ernst Schwarz called the pygmy-chimpanzee. They called it the bonobo, the name by which they are known in their mother country, the Congo.

The question has not been settled to this day. Some zoologists still insist the bonobo is a subspecies of the chimpanzee, other consider it a kinsman of the gorilla. However that may be, man has acquired a new relative in the family of anthropoid apes, and perhaps the one that is closest to him.

The English scientist Arthur Keith counted a total of 1,065 anatomical features in man. Of these, 312 are specific to Homo sapiens only, while he shares 396 with the chimpanzee, 385 with the gorilla, 354 with the orangutan, and only 113 with the lower monkeys.

It is as yet impossible to say exactly how many features man has in common with the bonobo, but certainly there are no less and perhaps even more than with the other anthropoids. At any rate, the structure of the bonobo's skull is closest to man's. The bonobo is the only known animal living today whose lips have a reddish tinge (in all other animals, they are usually black). In walking, the bonobo straightens out his knees in the same way man does.

Even today, the bonobo is still largely a puzzle.



And this is simply a domestic cat.

How Many Different Cats Are There on Earth?

The story of the cat is really extraordinary. And not merely because the cat has been worshipped as a goddess and persecuted as a witch. The cat has been living beside man for many centuries; it has served man faithfully, and yet it has remained independent, and in many respects, half wild. As distinct from other domestic animals, the cat has been in no hurry to reveal its secrets to man, and to this day there are many things about it that are still in the dark, as it were.

It is believed that the forefather of all domestic cats was the wild cat of Nubia which was brought to Egypt some five thousand years ago. Thanks to the homage given this animal in Egypt, we have a pretty clear idea of what it looked like. We can judge of its appearance from the mummies of cats given a royal burial and from figurines made of gold and silver, of which quite a few have been found in recent decades.

The Nubian cat had a small head with a pointed muzzle, long legs and a body which seems disproportionately long.

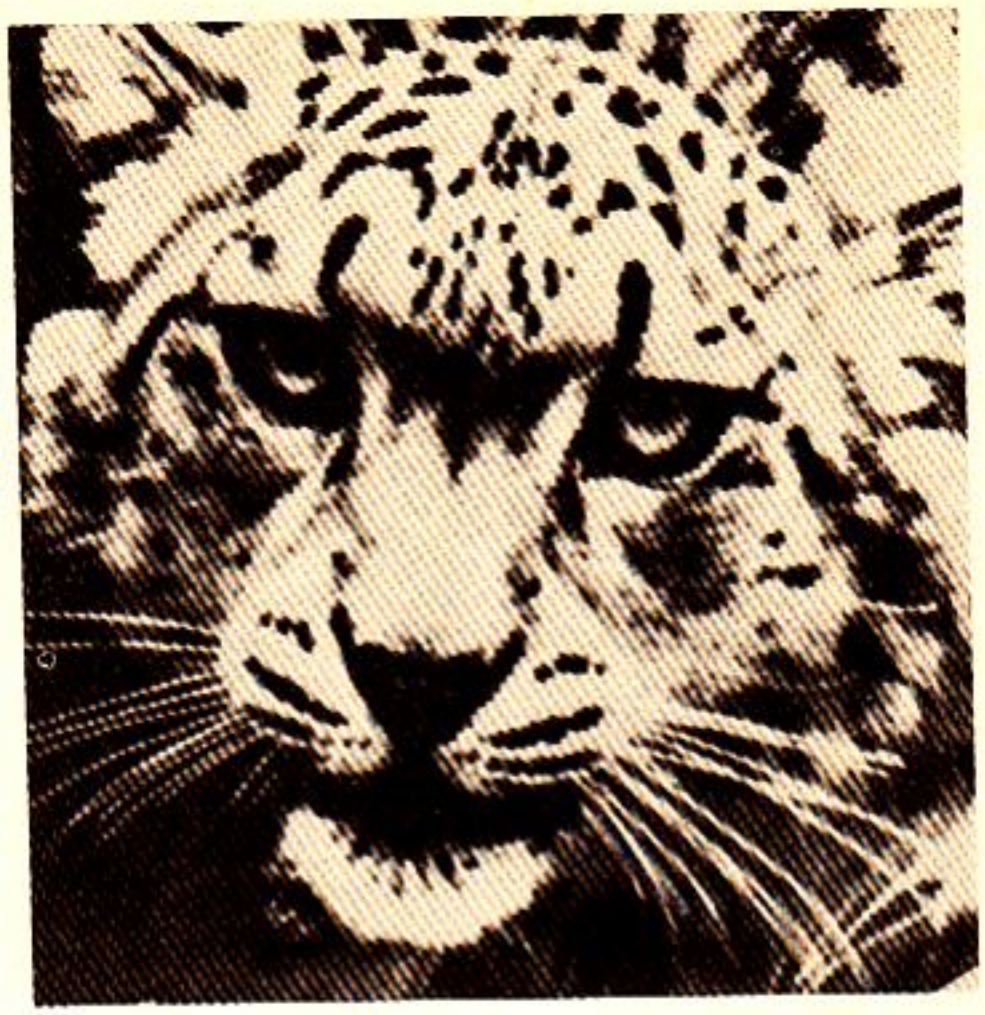
The cats depicted on Grecian urns look quite different.

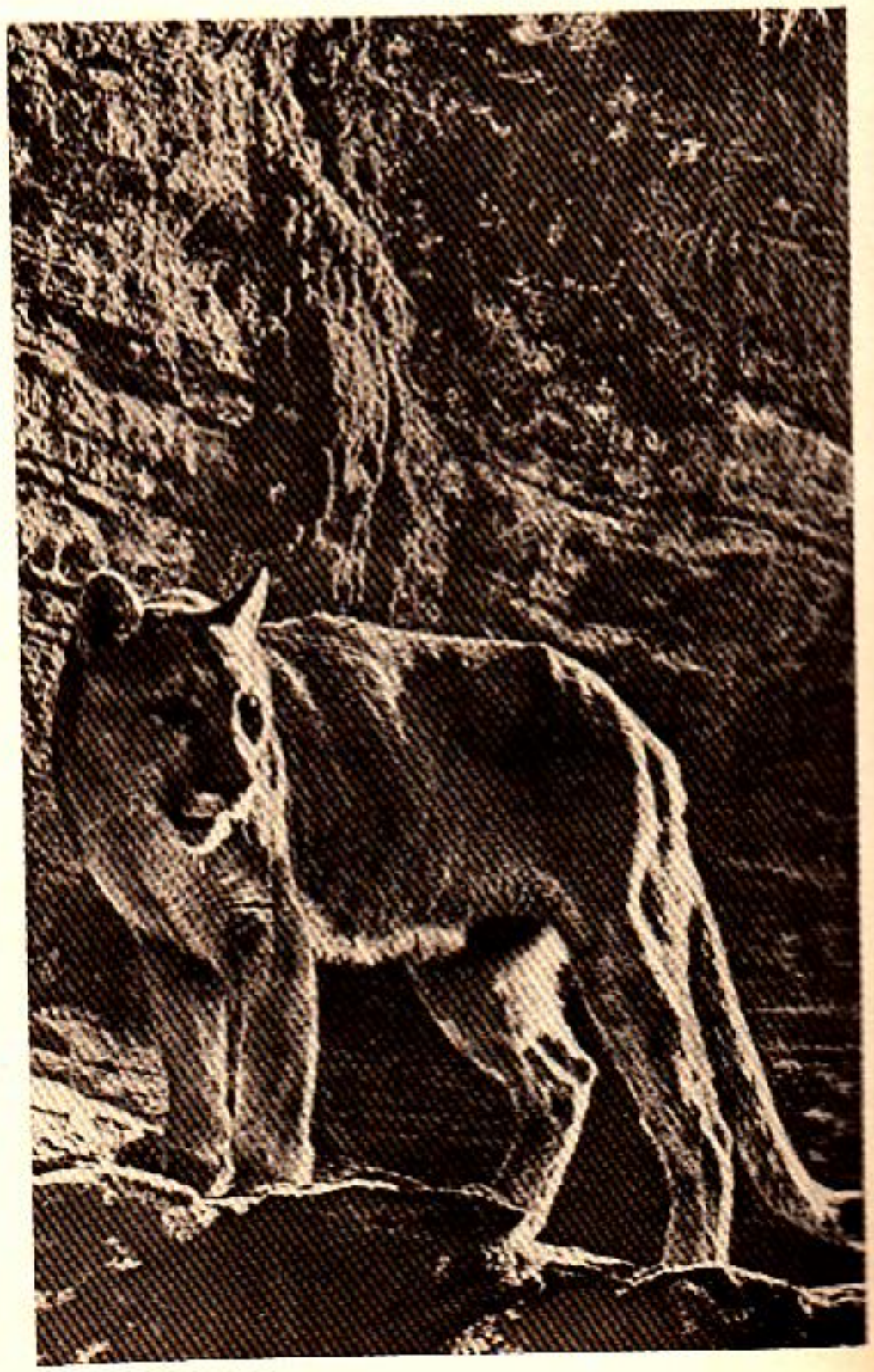
In the 10th and 11th centuries, cats made their way into Central Europe.

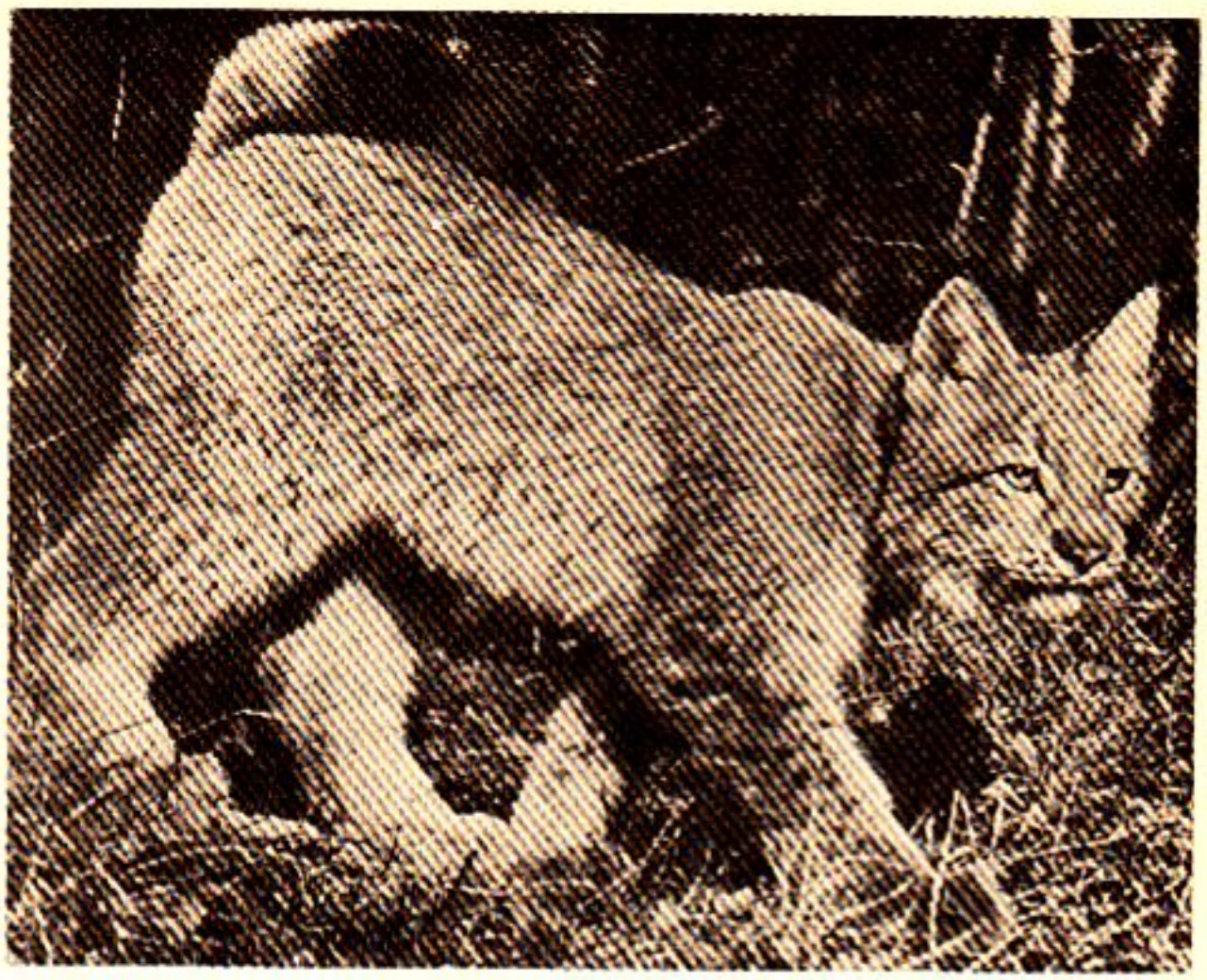
Their appearance changed again.

The cat reached Russia at the beginning of the 18th century. Before long, a distinct variety developed here, the Siberian cat. It emerged through the process of natural selection; nobody set out to develop this breed specially.

Actually, there is nothing surprising that cats should vary in appear-







They are all kinsfolk, the snow leopard, the puma and the lynx.

ance and that we keep seeing cats unusual in size, colouring, or length and thickness of coat.

Even the Ancient Egyptians crossed the Nubian cat with the swamp lynx, thus obtaining new varieties. Over the millennia that have elapsed since the numerous varieties of cats, beginning with the perfectly hairless Kenyan cat and ending with the long-haired cats cultivated in Asia, have become so intermixed that dozens of breeds have sprung up (although some zoologists deny the existence of any breeds of cats) with considerable distinctions. Moreover, if you have a large number of cats to choose from, you would be hard put to it to find two identical ones.

But whatever the differences and however heatedly cat-lovers may argue about their breeds, all domestic cats belong to one and the same species.

This species is quite numerous. Very approximate calculations yield a figure in the region of 500 million domestic cats living all over the globe. There is a vast army of white, black, tobby, red, grey and spotted animals which are both domestic and wild, both familiar and mysterious — creatures living a life of their own in cities and villages.

They have wild relatives, too. Though not numerous, they are highly varied. Among them are desert and forest and reed cats, the lynx, and the manul, the serval, and the ocelot, the snow leopard, and the clouded leopard, the jaguar and the puma, the panther, and the cheetah, and, finally, the tiger and the lion.

Perhaps the latter should have been placed at the beginning of the enumeration. But it so happens that it is precisely the cheetah, the lion and the tiger which do not permit zoologists to consider the list of felines complete. Because of these animals, we cannot draw a line and make a final count of the members of the cat family.

The cheetah is a very unusual cat in that it has not got much of the cat in it. The build of the body and its

proportions — the length of the legs — all suggest a dog rather than a cat. The legs themselves could have belonged to a dog. They are straight, hard and do not have the cat's contractible claws. Nor does the cheetah have the cat's distinctive stealthy gait.

For all that the cheetah is unmistakably a cat. It lives in Africa and West Asia, rarely occurring in the Central Asian republic of Turkmenia. Although the African variety is bigger, zoologists regard all cheetahs as belonging to one species. Then suddenly...

Legends have been told about this mysterious and fearsome animal for centuries. The local people supplied detailed descriptions of it and regarded it as a cross between the leopard and the hyena. Zoologists realised, of course, that such a hybrid was impossible. But what was it then? A new kind of cheetah with striped coat?

That was how it was finally classified, and the animal received the name of royal cheetah. But there were quite a few dissenters among the zoologists who held that it was no new species but just a freak of coloration. There was a lengthy controversy, with neither camp able to prove its point, since the only animal of this kind was killed in 1926 in Southern Rhodesia near Salisbury and no other specimen was ever seen again. The local people, however, stubbornly maintain that the animal exists to this day.

Another controversy — about a new species of lion, also on grounds of coloration — is still going on.

All lions known to science are evenly coloured, and the male has a well-developed mane. The lion in question is spotted, his mane is weakly developed, and he is much smaller than the ordinary kind. Could this also be just a freak, a chance mutation?

There is, however, yet another feature that distinguishes the spotted lion from all his kin: as distinct from the common run of lions who live in the plains, the spotted lion inhabits Kenya's mountain forests.

It would seem that all this warrants the classifying of this lion as a distinct species. Still, there are opponents of this view as well. So the question remains open, as is the one pertaining to the existence in Australia of the marsupial tiger. The testimony of people who have seen the animal with their own eyes, killed him and even caught him alive, their detailed descriptions of him and his habits have convinced many zoologists that the animal actually exists. On the other hand, there are any number of sceptics who hold that it is just an incorrect use of the term and that the animal in question is the marsupial wolf which has stripes on its sides and is for this reason mistakenly called a tiger.

Be that as it may, the list of felines cannot yet be considered complete. It recently received an interesting addition in fact.

In 1967, the zoological world was shaken by the news that an unknown species and even genus of cat had been discovered on the Island of Iriomoteshima in Japan.

Rumours about unusual wild cats living on the island had been rife for a long time previously. But it never occurred to anyone that they were truly unusual and genuinely wild cats.

Indeed, Japan is so densely populated that it is hard to believe that an unknown wild animal could possibly live there. Perhaps these were domestic animals gone wild.

However, the Japanese zoologist Yukio Tagawa decided to verify the rumours. Local people enthusiastically joined in the hunt. Before long, the zoological world heard about a remarkable discovery — a wild cat that was the only representative of a new genus within the cat family.

Not so long ago our domestic cat had 36 kinsmen. Now there are 37.

There may be more for all we know.

Three Unexpected Discoveries Made in a Shop, a Cinema, and a Storeroom

About eight and a half thousand species of birds are known to zoologists today. Some of them have been known to people since time immemorial and came to the zoologists' notice since they began making classifications. Others which inhabited inaccessible forests, swamps or mountains became known only recently. Some were discovered and described fairly easily, others, only after distant trips and dangerous travels. But it was not always like that...

One summer day in 1937, the American ornithologist Masa U. Hachisuka was passing a small shop on a street in San Francisco. He had never been in that shop before, though he was in the habit of dropping into shops that sold bird cages, feed, and, of course, birds themselves.

This time he entered the shop. It was much like other shops of this kind — birds in cages everywhere. But here, Hachisuka could not believe his eyes. In one of the cages hopping on the perches he saw birds he knew nothing about.

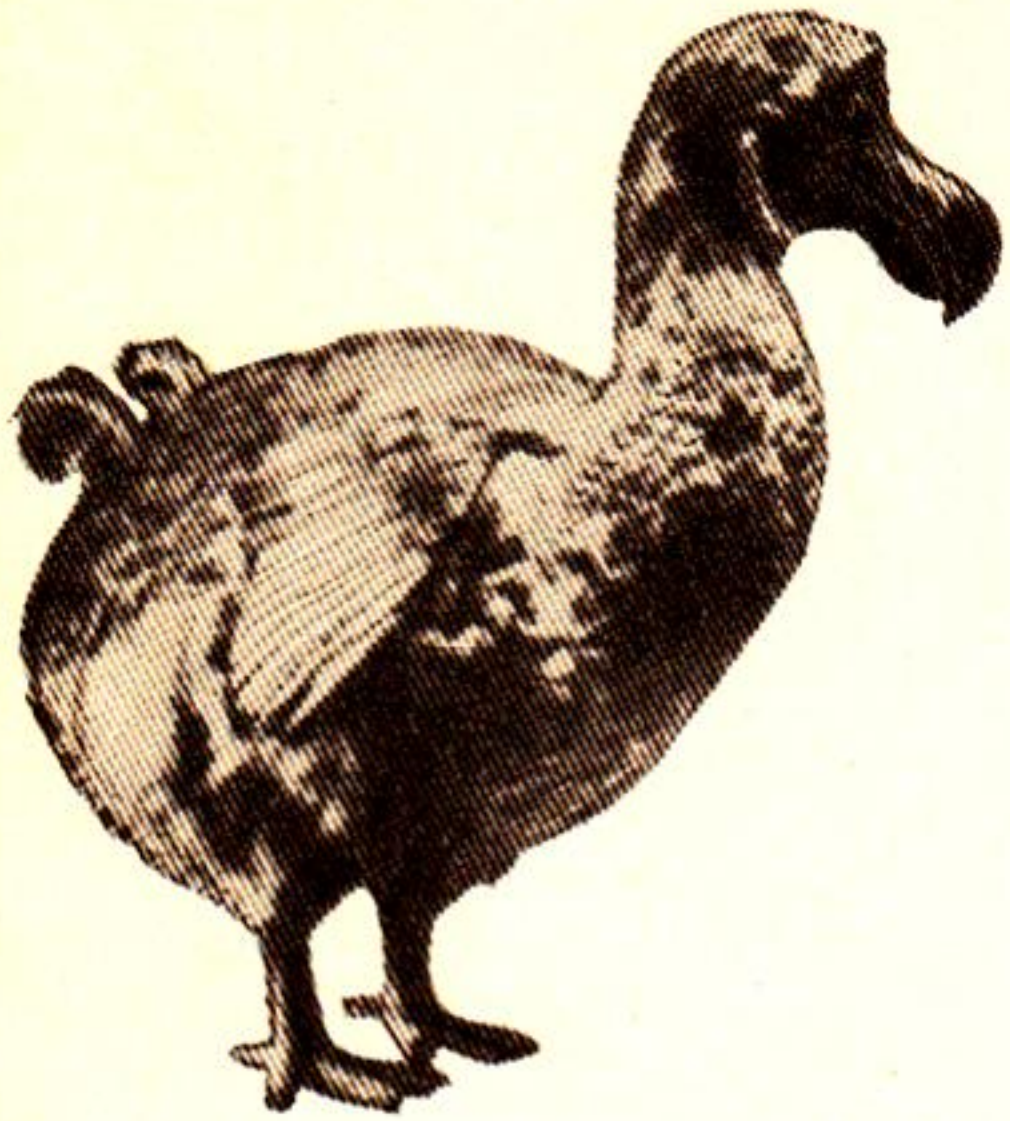
To be precise, the birds looked like chaffinches, but differed from all known birds of that family. The owner of the shop was very much surprised to see the newcomer getting all worked up about the birds. He was more surprised still when the newcomer began to question him nervously about the birds' name and origins. Goodness, every year hundreds of these birds were brought to San Francisco from Manila in the Philippines. The shop-owner decided he was dealing with somebody who did not know much about birds. Otherwise he'd have known that bird fanciers often kept such birds, and all the zoos had them as well.

But when the strange customer bought all the birds of this species in the shop, the shop-owner was at a loss what to think. Was the man mad?

Hachisuka, meanwhile, ran home like one possessed. He had to check things, to see whether he had been mistaken or not. It was too incredible — a species of birds unknown to zoologists kept by bird fanciers and zoos!

No, he had not been mistaken. It was, indeed, a new species of chaffinch. Together with another zoologist, Delacour, Hachisuka studied the Filipino chaffinch, described it, and the bird took its lawful place in the list of birds known to zoology.

However accidental was the discovery made by Hachisuka, it was made in a shop that sold song-birds where he was taken by professional curiosity. Not so with Doctor Ingo Krumbiegel, who made a discovery while taking a rest from his professional pursuits. He went to see a film about the Antarctic made by an American expedition. Doctor Krumbiegel emerged from the cinema in a state of great agitation. He had seen penguins on the screen which mystified him greatly. It was not that he had never seen penguins be-



A dodo. Nobody will ever see the bird alive.

fore. He had, and not just on the screen. He was an authority on penguins and was thoroughly familiar with all the seventeen known species. But the birds he had just seen on the screen did not belong to any of these seventeen species.

Was it a new species then, the eighteenth?

Neither the members of the expedition, nor its head, Admiral Richard Byrd, had had a notion that there was anything special about the penguins they had filmed. Oh yes, there had been a lot of them. They filmed them and they also sold the birds they had caught to a zoo in New Zealand.

A new species?

It was a sensational discovery, made as it was in a cinema in Germany instead of by American or New Zealand zoologists, who had had an incomparably greater opportunity to make it.

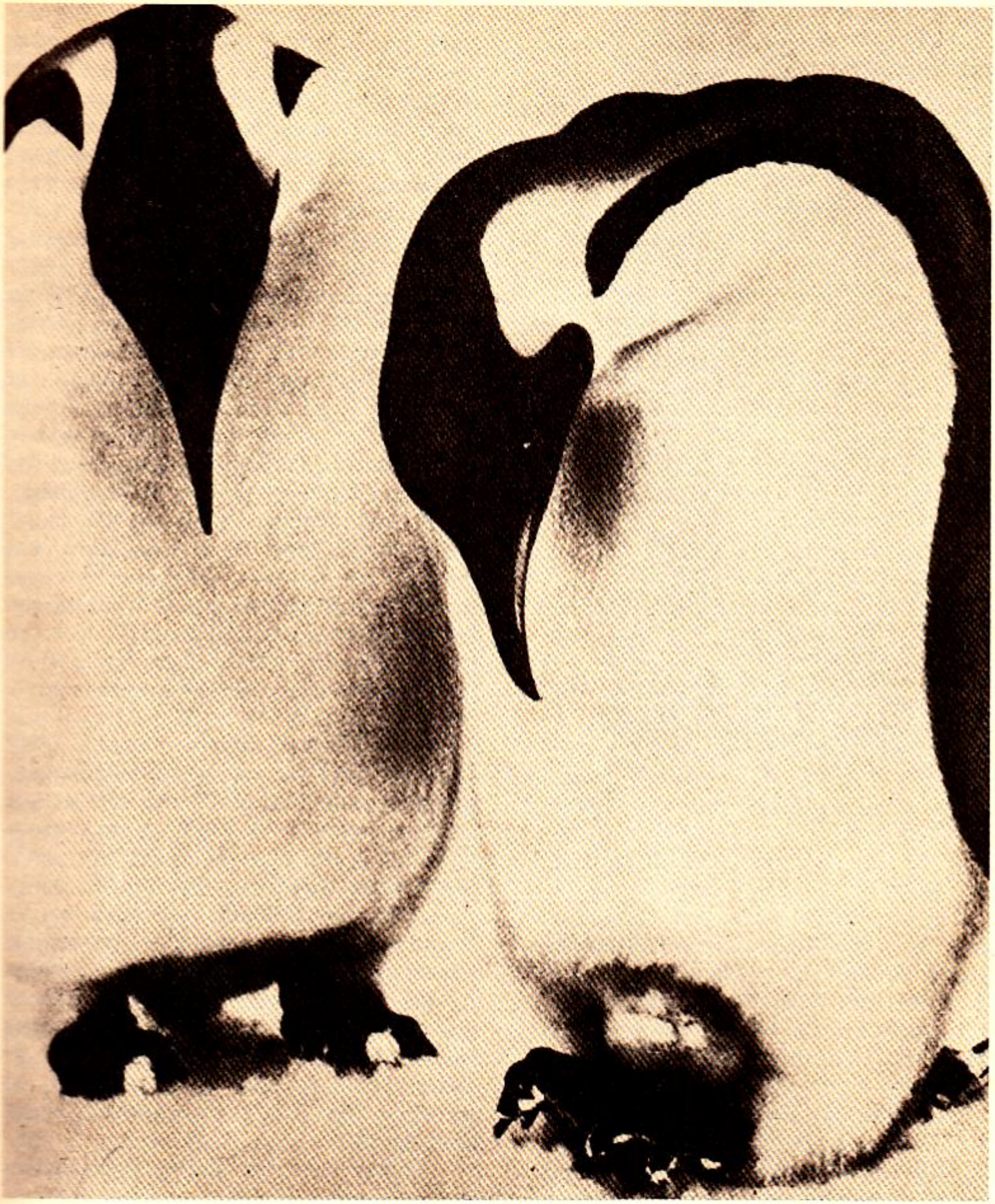
The discovery of new birds is not such a very rare occurrence in zoology. To say nothing of past centuries, several dozen new species of birds were discovered in this century. In 1938, zoologist Edgardo Moltoni, for instance, found a bird in Ethiopia for which a special family had to be set up, for it could not be ranked with any of the existing families, being something between a crow and a starling.

The bird discovered by James Chapin also belonged to a new family. And he found it in a storeroom!

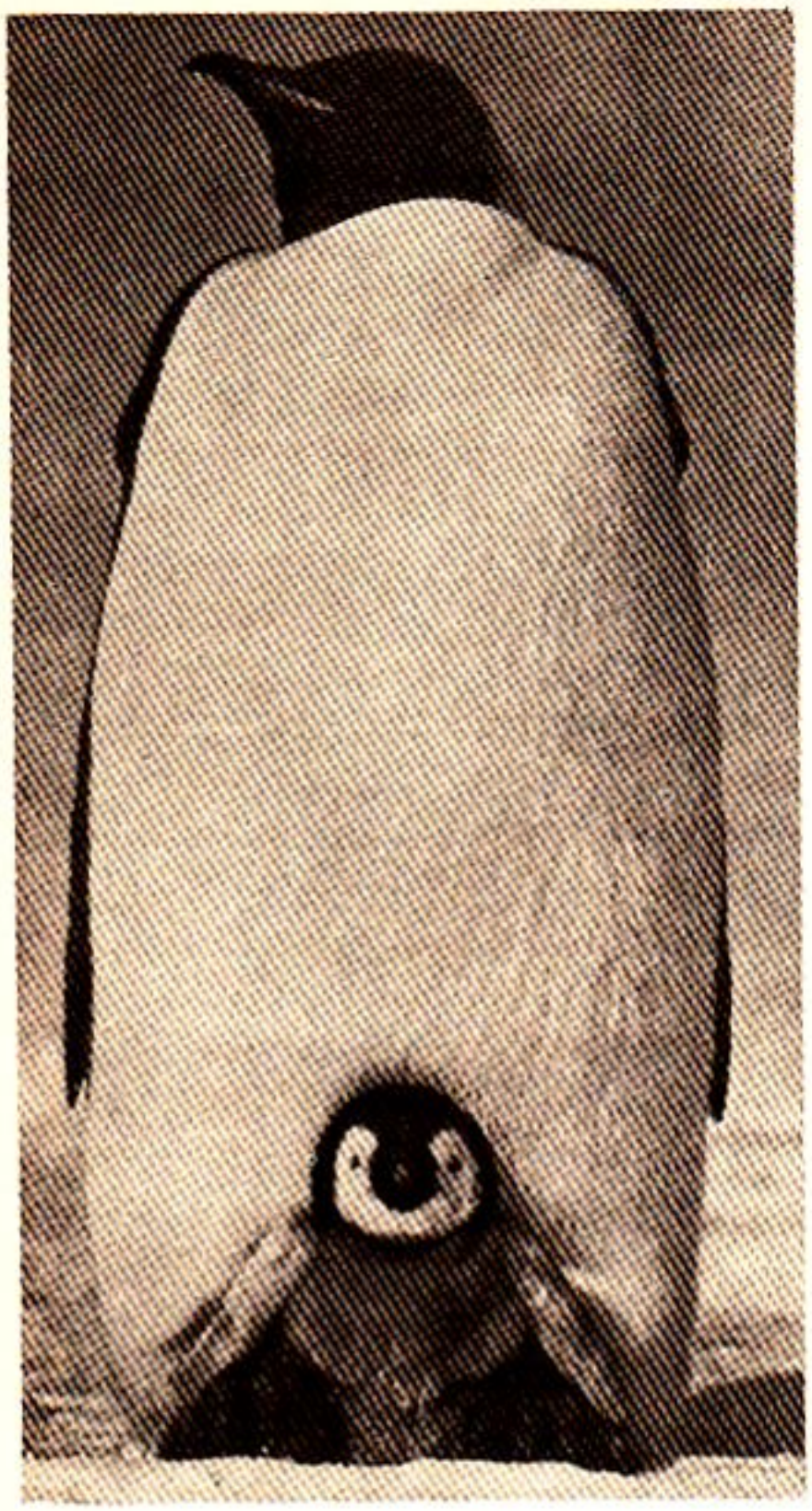
In 1936, Doctor Chapin left the United States to visit Belgium to do some work in a Belgian museum. He was interested in African birds and wanted to supplement the large collection he had brought from expeditions with material from the museum funds. Being a person of an inquisitive mind, he made a thorough study of all the museum's repositories and finally arrived at a storeroom which contained spoiled exhibits the museum had no use for. Still, the American zoologist decided to examine the contents. In a cupboard, he found several stuffed birds that he could not place. When he looked at them, something surfaced in his memory which blotted out all other thoughts.

Twenty years before, as a young man, he had taken part in an expedition to Africa. The collections the expedition brought home included some headgear worn by the natives. Some of the feathers in them seemed to belong to a bird science knew nothing about. Even the best ornithologists were unable to identify them.

And now he was looking at stuffed birds covered with these same feathers! But what birds were they? The inscriptions said they were young pea-



A father penguin while hatching a fledgeling keeps the egg on his feet, warming it with his body and never letting it touch the snow.



And here is the fledgeling!

cocks. But the museum specialised in African fauna, and peacocks did not live in Africa. Nor did the birds look much like peacocks or any other known African bird for that matter. That was what must have misled the museum workers. Experts on Africa, when they received those stuffed birds twenty-five years before, must have decided that they weren't African birds. So they were relegated to the storeroom.

Chapin flew to Africa. Zoologists the world over were impatiently awaiting the results of his trip. They did not have to wait long: the remarkable birds proved to be well known in the Congo. They took no pains to hide from man, cried loudly at night, and, when flushed, flew up quite noisily. Besides, their meat had an excellent flavour, and they were desirable game.

Why, then, had this bird been overlooked by zoologists? Nobody could supply an answer to this puzzle. Chapin did not know either, nor was he particularly concerned with this aspect of the problem. His main interest was in the bird itself. Yes, it proved to be a peacock, but one that differed greatly from its Indian counterpart. On the other hand, the birds had to be related, since both were peacocks. It was eventually established that they were not merely related but that the African peacock was a distant ancestor of the Indian one and much "older". Yet the Indian peacock was known to all, while the African one languished in obscurity.

Well, stranger things happen. Only a couple of decades passed between the puzzled examination of the mysterious feathers Chapin brought from Africa and the description of their "owners", the African peacocks. Mind you, many more unidentified feathers are to be found in various zoological museums, and it is quite possible that somewhere in the impenetrable forests of South America or Africa, and perhaps in ones not so impenetrable, the "owners" of these feathers, as yet unknown to science, are flying or running about at large.

At any rate, ornithologists maintain that at least a hundred species of birds unknown to zoology live on the earth today. At least a hundred! And perhaps many more.

Dragons Are Real After All!

Yes they are! To begin with, only one man was convinced of it, and one who was very far from zoology at that. Zoologists, on the other hand, when told about the fearsome dragons which lived on some islands of Malay Archipelago shrugged their shoulders sceptically. Indeed, who was going to believe in the existence of monsters six metres in length who were endowed with tremendous strength, could eat a whole boar at once, and, on top of that, spewed fire from their mouths!

It would seem that the discovery of the okapi and the huge rhinoceros, the gigantic gorilla, and other animals made at the beginning of this century might have induced zoologists to give more credence to the stories of the local population. But tales about the dragon seemed too fantastic to be believed.

And then, in 1912, the existence of dragons was confirmed by a European, the first white man to see those monsters with his own eyes. He was a pilot of the Dutch air force who made a crash landing on the little island of Komodo and had to live there for a considerable time. Upon his return to Java, he wrote in his report about huge reptiles, or dragons, he had seen with his own eyes. Essentially, his report repeated the stories of the local people already known to zoologists. But since zoologists refused to recognise their existence, the military authorities saw no reason to meddle with something that was not their concern. What the zoologists did not know, the military did not want to find out about.

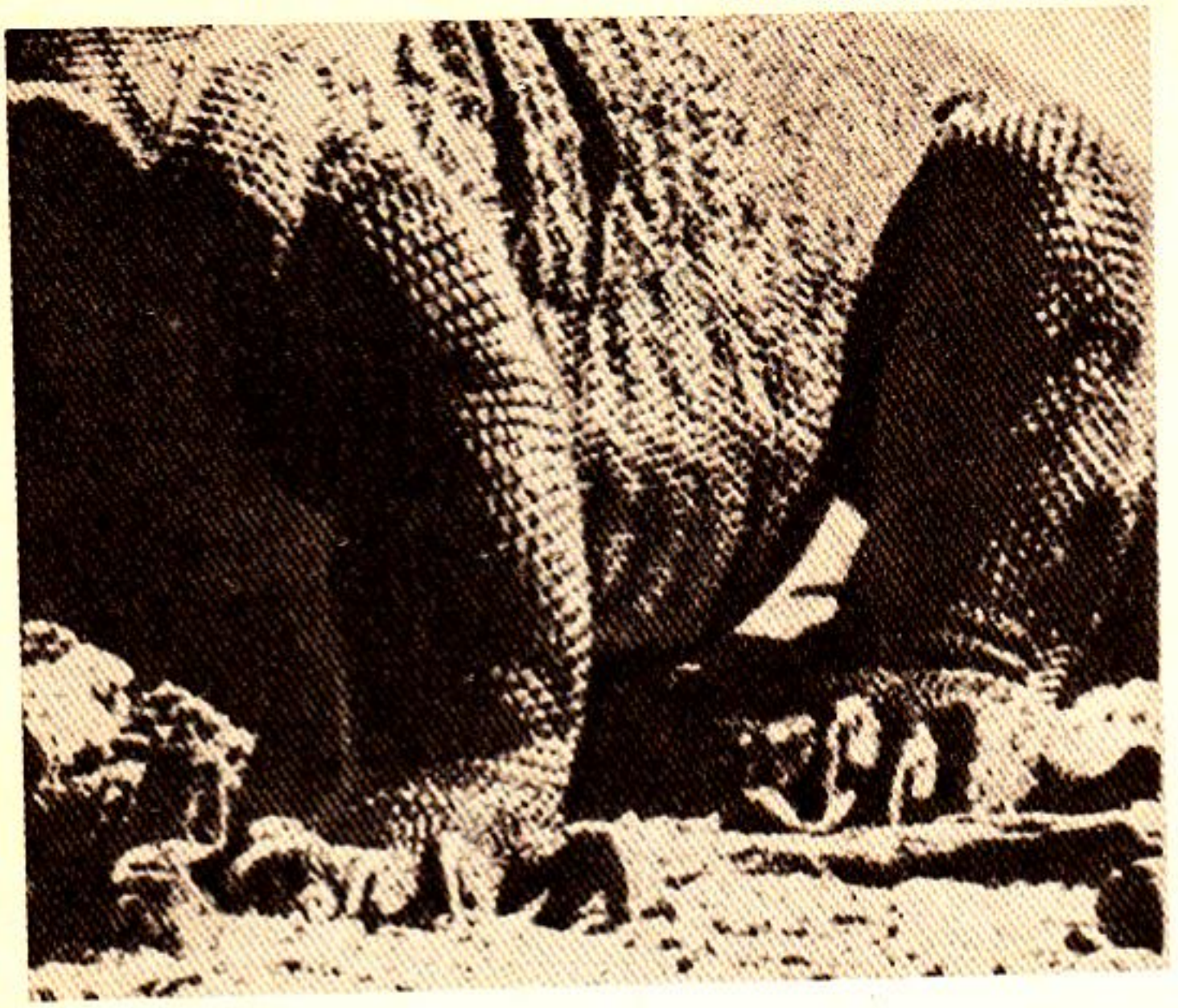
But the pilot was so persistent with his stories that his superiors suspected the hardships and dangers he had experienced had affected his mind. The question of despatching him to a lunatic asylum was seriously considered.

There was one man, however, who heeded his story. He was the curator of a Javan museum, Major P. A. Ouwens, a passionate naturalist, a dreamer and a sober scholar at the same time. So he wrote a letter to a friend of his, Dutch army officer Van Steyn who was serving on an island quite close to Komodo. Ouwens asked his friend to pay a visit to Komodo and verify, as far as possible, the pilot's story. It took Van Steyn some time to comply with this request, but comply he did, and he satisfied himself that the dragons did exist. He was well aware, however, that his story, uncorroborated by any material proof, would be taken for just another wild tale. To avoid such an eventuality, he killed two dragons and sent their skins to Ouwens.

Now, even the most inveterate sceptics could no longer deny the existence of legendary monsters. Ouwens, who described them in a zoological magazine, proved that they were simply giant monitor lizards whose relatives were well known to zoologists. But the size of these creatures! Van Steyn sent Ouwens the skins of medium-sized dragons, but even these were nearly three metres in length.

Ouwens' report stirred the scientific world. One expedition after another went to Komodo Island. Sensational reports made the front pages of newspapers. Soon, however, the First World War began, and people could no longer be bothered with dragons.

The world-wide slaughter carried away millions of lives and inflicted untold suffering on people. At the same time, kings of steel and guns, thieving commissars and other adventurers



On the left is a unique photograph of a Komodo dragon; on the right, an old engraving depicting a battle with the dragon of the fairy tale.

thrived on the blood of their fellow-citizens. The nouveaux riches did not know how to dispose of their ill-gotten gains. The oversated moneybags and their wives and offspring thirsted for the unusual and were prepared to pay any kind of money for it.

Would a bag or a pair of shoes made from the hide of the recently discovered dragon qualify?

Chinese businessmen were already dispatching hunting expeditions to Komodo in 1915. They knew they could count on vast profits from the dragons killed. A few hundred of them, and their fortunes would be made. But the Chinese merchants failed to put dragons to good account, and the wives and daughters of the nouveaux riches never sported bags and shoes made of their skins. Luckily for science and the dragons themselves, their skins proved unsuitable for tanning, and again they were forgotten.

It was only several years after the conclusion of the First World War that the Komodo dragon again hit the headlines. It was established by zoologists that the Komodo dragon was an exact replica of giant monitor lizards which had at one time lived in Australia and whose skeletons had been found there. But the Australian dragon lived 60 million years ago, while his Komodo cousin is our contemporary. This posed a host of seemingly unanswerable questions. Here is one: the Australian dragon became extinct 50 or 60 million years ago. On the other hand, Komodo Island and the two neighbouring islands were of volcanic origin and formed at a much later date. But even if we assume that some of Australian dragons lived until Komodo came into being, in what manner did they reach the island? Surely they could not swim across such a vast distance against the strong current typical of these seas.

An answer to this and similar problems could only be obtained by a thorough study of the Komodo dragon, as the animal came to be almost officially known.

But the expeditions which went to Komodo confined themselves to photographing and describing the dragons, killing a few specimens to obtain skins and skeletons, and catching a few young animals for zoos.

The first fundamental study of the Komodo dragon was undertaken almost fifty years after their discovery, in 1959, by the French zoologist Pierre Pfeffer. The Soviet expedition led by E. A. Maleyev which went to Komodo in 1962 completed his work.

The investigation confirmed much of what had been regarded as fantastic embellishments of the local people. Besides, many new interesting discoveries were made.

When the zoologists first saw the dragon, they understood how the legend about flames spewing from their mouths originated: the long forked tongue, which the dragon keeps sticking out to feel the objects in its path is bright red and really could be taken for a tongue of flame from a distance. We know that fear distorts people's vision, so a small "fiery" tongue grew into raging flames.

It is possible that stories about dragons seven to ten metres in length were also fathered by fear, for scientists have not encountered a single monster of this mammoth size. But even a three-metre reptile with an enormous head, eyes that gleam in the sun, heavy folds of skin on its neck, and the skin itself, covered with bone lamellas, the huge tail and fairly long thick legs, and powerful jaws with twenty-six sharp teeth three or four centimetres in length — all this is im-

pressive enough and extremely reminiscent of the gigantic prehistoric reptiles which became extinct many million years ago. No wonder people go in mortal fear of the dragon and ascribe extra metres of length to it. On the other hand, it may well be that bigger dragons used to live on the island and were seen by the local people. But what happened to them? If they died out, their skeletons ought to be found. While pondering the question, zoologists suddenly became aware that no skeletons or even bones of these animals, large or small, had ever been found on the island. Pierre Pfeffer even decided that because of scarcity of food, the dragons hunted their own weaker brethren.

This supposition was more than warranted: there are few animals on Earth as voracious as these dragons. Pfeffer watched a dragon eat almost all of a small deer that was laid out as bait.

Soviet zoologists saw four reptiles devour in a matter of a few minutes 80 kilograms of meat, tearing off five-kilogram pieces and swallowing them without chewing, bones and all. In the stomach of one reptile, they found a whole head of a wild boar. Having eaten, the dragon rests for some time, digesting his food, and then goes hunting again. Like most reptiles, it does not pursue its prey, but lies in wait for it. It knocks the animal which had been uncautious enough to approach it with a blow of its tail, only avoiding buffaloes, presses it to the ground and bites through its carotid artery.

Dragons hunt smaller animals as well. Waiting until a band of monkeys comes down from the trees in search of berries and fruit, a dragon will tear into the very midst of them. The monkeys, paralysed with fear, make no attempt to escape, and the reptile catches whichever takes its fancy.

Nor do these huge predators, weighing up to 200 kilograms, scorn such small fry as birds, snakes, lizards, rodents and even insects. Incidentally, Komodo, in the local vernacular means the Island of Rats. Apparently, not so long ago, it was infested with rats. Today there are very few left: the dragons have eaten them up.

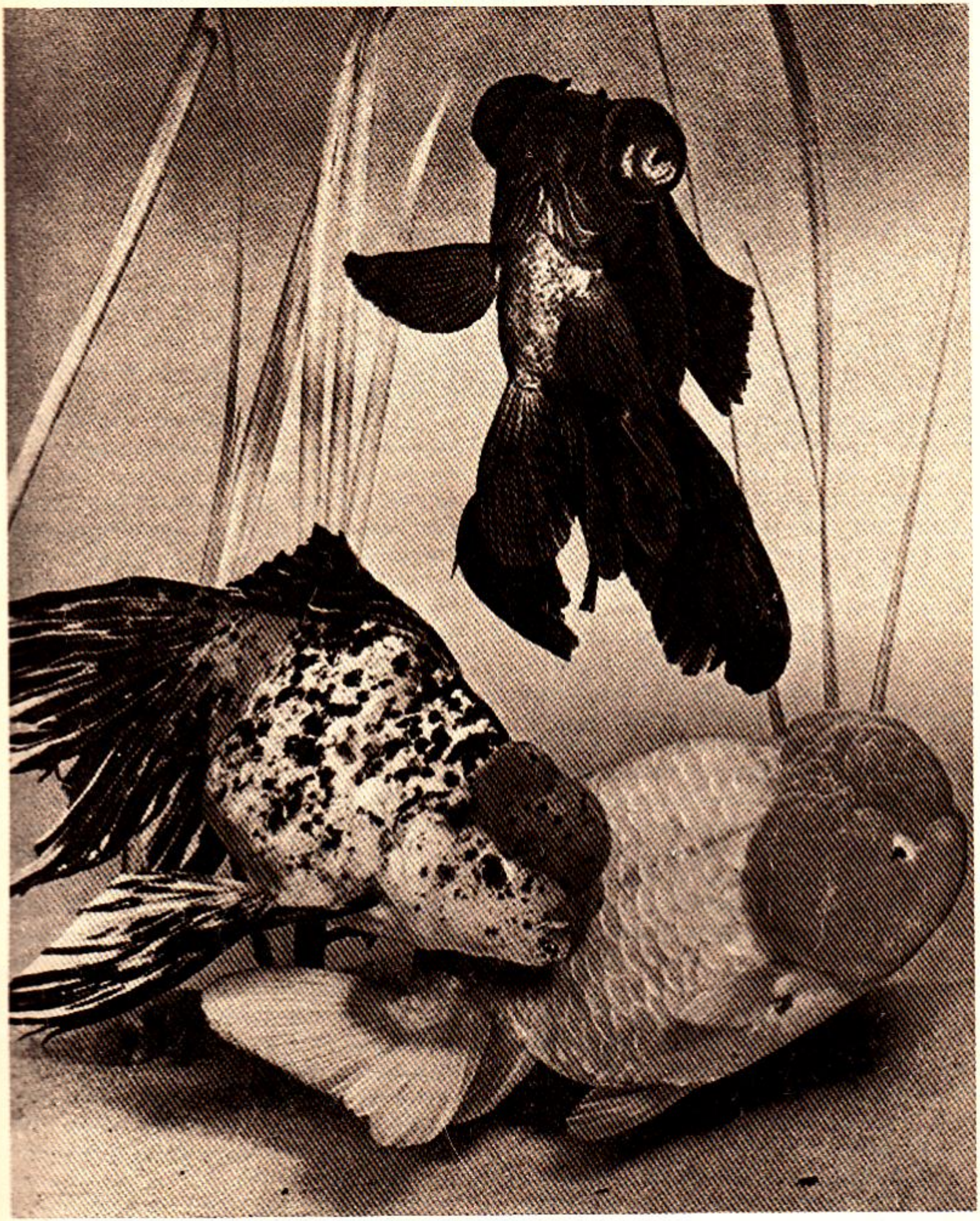
So, dragons are real, even if they are mere monitor lizards. The important thing is the kind of lizards they are — huge prehistoric reptiles!

This fact has been proved. The diet of the dragon has also been established. We know that the female lays from 5 to 25 eggs the size of a goose egg, and that tiny dragons are hatched from them eight months later. They grow rather slowly. The life expectancy of a dragon is 40-50 years.

This much is known, but many more questions remain unanswered. One of them is where the skeletons disappear to. Pfeffer was mistaken suggesting that the dragons eat each other. They don't. But perhaps they eat the corpses of their dead brethren — after all they do not disdain carrion. Or do they devour old reptiles unable to attack or defend themselves?

Then there is the question of whether the dragons can hear. It had been established that they do not perceive the human voice. It was believed that they were deaf, but it was subsequently discovered that they could hear certain sounds. They also perceive sounds travelling through the ground.

And what about their origins? It has now been established beyond doubt that the Komodo dragons hie from Australia. But how did they reach the island? Did they swim all the way? One thing we do know is that they are



Some goldfish used to live in rivers and lakes, others were specially bred by man.

excellent swimmers. Soviet zoologists took some far out to sea, and the dragons soon found their bearings and safely reached the shore. But it is one thing to swim home from the open sea and quite another to cover an enormous distance.

Although the Komodo dragon has been discovered, it remains a mysterious and unfathomed animal.

Ocean Dwellers

In the beginning of last century, ichthyologists knew some 1,400 species of fish. Ichthyology had not yet come into its own as a special branch of zoology, but there were quite a few people who devoted themselves exclusively to the study of fish. It is hard to say, though, how fast the list of known fishes would have grown, and it certainly would not have made such leap and grown threefold within a short stretch of time had not Cuvier turned his attention to the fishy tribe. As was his wont, Cuvier pitched into his investigation with fervour and passion. Moreover, his opportunities were great indeed: a responsible government official, he was able to recruit ship's doctors, who brought him fishes from all corners of the globe, caught not only in seas, but also in the rivers and lakes of Africa, South America, Asia and Europe.

Cuvier described nearly 5,000 species of fish. Since his time, in a century and a half, the list of denizens of rivers, seas and oceans has grown four times. Today we know nearly 20,000 species of fish.

Naturally, the ichthyologists of today have immeasurably greater opportunities than Cuvier had. It was only in this century that man peered into the depths of the ocean: the first deep-sea dive ever was performed by William Beebe in 1930. In a strong metal sphere, he reached a depth of 240 metres. And during that first plunge, Beebe and his companion Otis Barton saw a whole new world unknown to science. In 1934 Beebe went down again, this time reaching a depth of 923 metres.

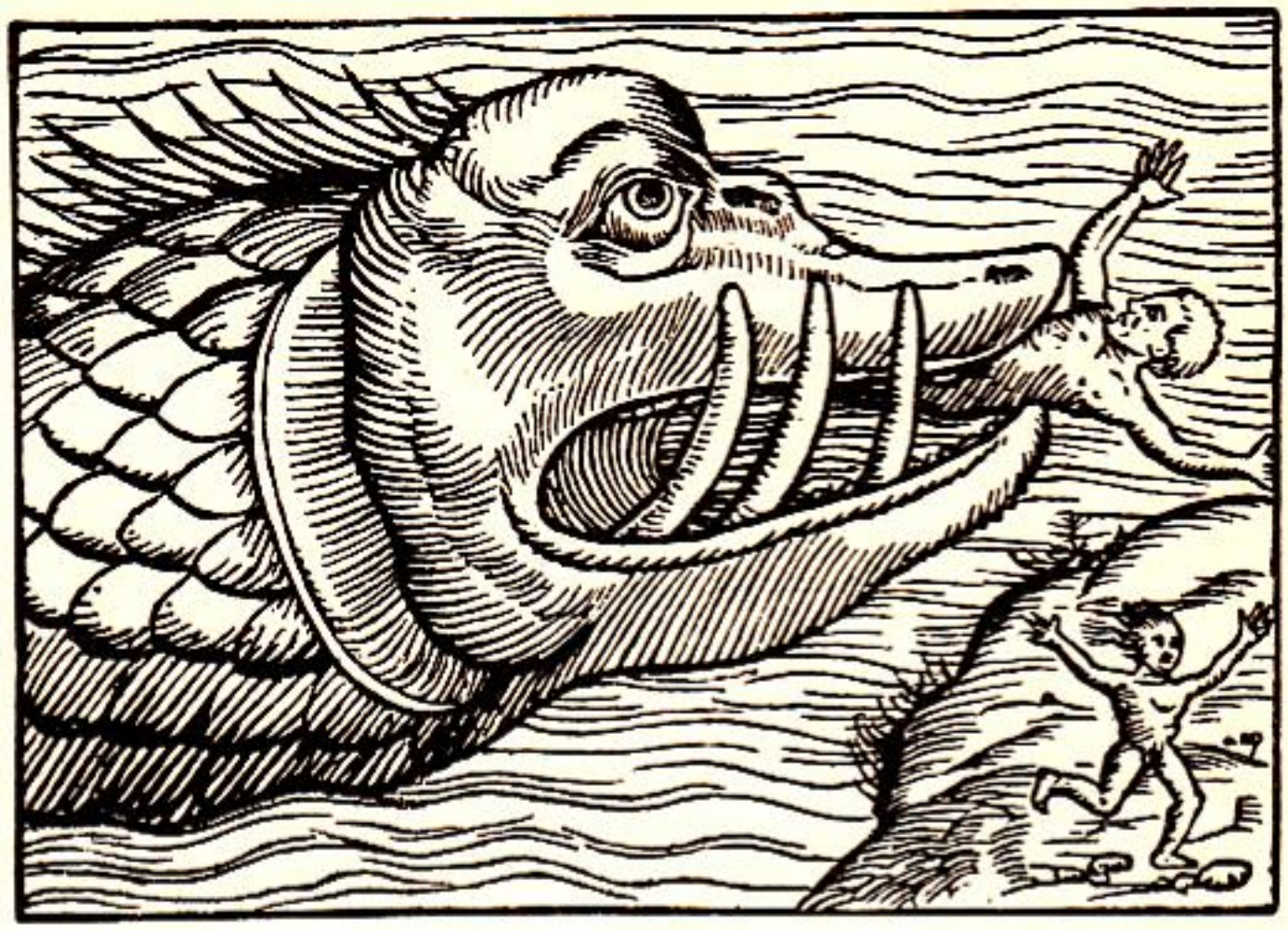
But it was not only seas and oceans which jealously guarded their secrets. Interesting discoveries were made in small rivers and even springs, or by aquarium owners.

This is what happened with a little fish which aquarium fanciers today know by the name of cardinal. Yes, the fish is well known today, but forty years ago not even major ichthyologists had the faintest notion of it. It was only in 1932 that several cardinals were first brought to Europe as a present to English goldfish lovers.

This small pretty fish, with a blue body and red fins won the fanciers' hearts, and today the cardinal is widespread in Europe. But here it lives only in aquariums, like another domestic fish, also discovered recently and named the neon tetra.

August Rabot was not a zoologist or a traveller. He was brought to the Amazon by the desire to get rich and was in no wise concerned with studying an unknown land or discovering animals new to science. Rabot knew the price rich people were prepared to pay in Europe for tropical butterflies or orchids. And so he set out to make his fortune in butterflies and orchids. But then he heard about the diamond works and turned his attention to precious stones.

Once in the midst of the continent, however, Rabot fell dangerously



People have always been convinced that seas and oceans are populated by fantastic creatures.

ill. Diamond prospecting was out of the question. He convalesced in a small Indian village, and here he found something which brought him as much wealth as diamonds were ever likely to. He discovered small, amazingly beautiful fish. The enterprising Frenchman was quick to appreciate their worth and, surmounting great difficulties, brought them to Paris.

He was not disappointed. The fish, which were named neon tetra produced a sensation and made him a rich man. Dozens of adventurers went to South America in search of some other kind of wonderful fish. Some did, indeed, succeed in bringing back fish unknown to science. These fish complemented collections of aquarium fanciers and took their rightful places among the species discovered in this century.

Many of these exotic fish are quite tiny. But for all that, they are true giants compared to the miniscule *Pandaka pigmea* discovered on the Philippines. It is less than a centimetre in length and is the smallest vertebrate known.

The pygmy fish is certainly a wonder, but more wonderful still is the "mammal" fish which was recently discovered in the Amazon. Of course its "milk" is very different from a cow's or goat's, but it's milk all the same.

As soon as the fry of this fish are hatched, they swim up to their mother and never leave her side until they grow up. For if they do, they will perish of hunger, not being in the least interested in the minute water plants, microscopic crayfish and other tiny things that usually comprise the diet of small fry. These feed exclusively on their mother's "milk", a liquid secreted by special glands on its sides.

Among the other unusual fish are the "underground dwellers", which were discovered fairly recently in artesian wells at the depth of over 1,000 metres! This fact suggests another, even more interesting one: there must be fish (and perhaps not only fish) living in underground rivers and lakes (apparently it is from there that the fish in question made their way into artesian

wells). The conditions of life there are certainly unlike anything occurring anywhere else on Earth. But yet, these creatures have adapted to them.

Actually, fish are amazingly adaptable. For instance, they are capable of living in hot water. We know that fish usually perish if the water temperature exceeds 30°C. But then a kind of fish was discovered in California which thrives in hot springs though the temperature there is above 50°C!

Zoologists believe that this fish has some special adaptation mechanism, some kind of "heat-reducing" device which makes it possible for the creature to live in hot water.

Fish which were discovered by Soviet scientists in the Antarctic, on the contrary, had to adapt themselves to life in freezing water. They have no hemoglobin and erythrocytes in their blood, and although the implications of this fact have not yet been ascertained, enough is known to show that fish with white (or, to be more precise, colourless, transparent) blood are, indeed, unusual creatures. But the phenomenon is not all that rare, as we now know: in the interval which has elapsed since 1956, when members of a Soviet Antarctic expedition discovered three species of white-blooded fish near the Island of Kerguelen, dozens of fish of this type have been found.

New species are constantly being discovered.

Not so long ago, Jacques Yves Cousteau, the famous French student of the deep sea, reported that in the last few years, near the coast of Argentina alone, ichthyologists on his team have discovered more than a hundred new species of fish. And this is close to the coast! But modern zoologists have the opportunity to study sea life far from the coast as well.

Zoologists, botanists and oceanographers have divided the ocean water into two layers, as it were. The top layer runs 200 metres deep, and the rest, all the way to the bottom. The depth of this lower layer exceeds 10 thousand metres in places.

Essentially, as numerous discoveries confirm, even the upper layer has not yet been thoroughly studied, to say nothing of the lower one. There, in the depths, live giant squids which do not

hesitate to give battle to the sperm-whale itself. People have witnessed these duels from afar and found on the whales they killed marks of suckers from these squids' feelers — each the size of a soup plate.

But so far, nobody has been able to obtain a specimen of those squids or even photograph one. But it has been established by deep-sea photography that on the ocean floor live gigantic star-fish with a diametre of up to 70 centimetres. Traces of some other huge sea animals can also be seen on the photographs, as well as many other curious things.

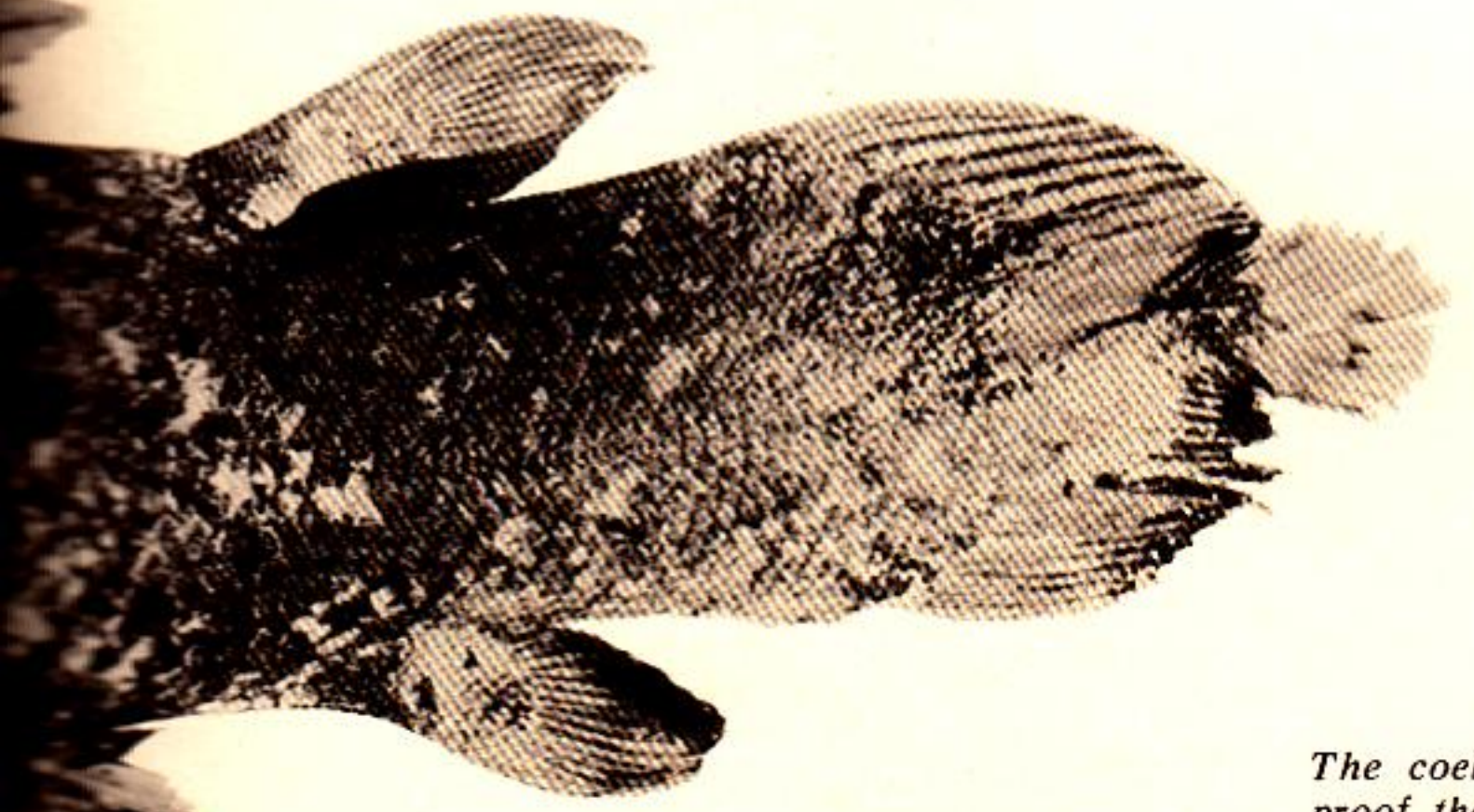
But photography is not the most effective method of studying marine life. The most amazing discoveries are made with the help of deep-water trawling.

In 1949, the Soviet exploratory vessel *Vityaz* undertook a systematic study of the ocean floor at the depth of 10,000 metres. This was the first such venture in the history of science. And not merely because the technology had not previously been developed for looking so deep into the ocean's depths, but also because many zoologists were sure that life at such great depths was impossible.

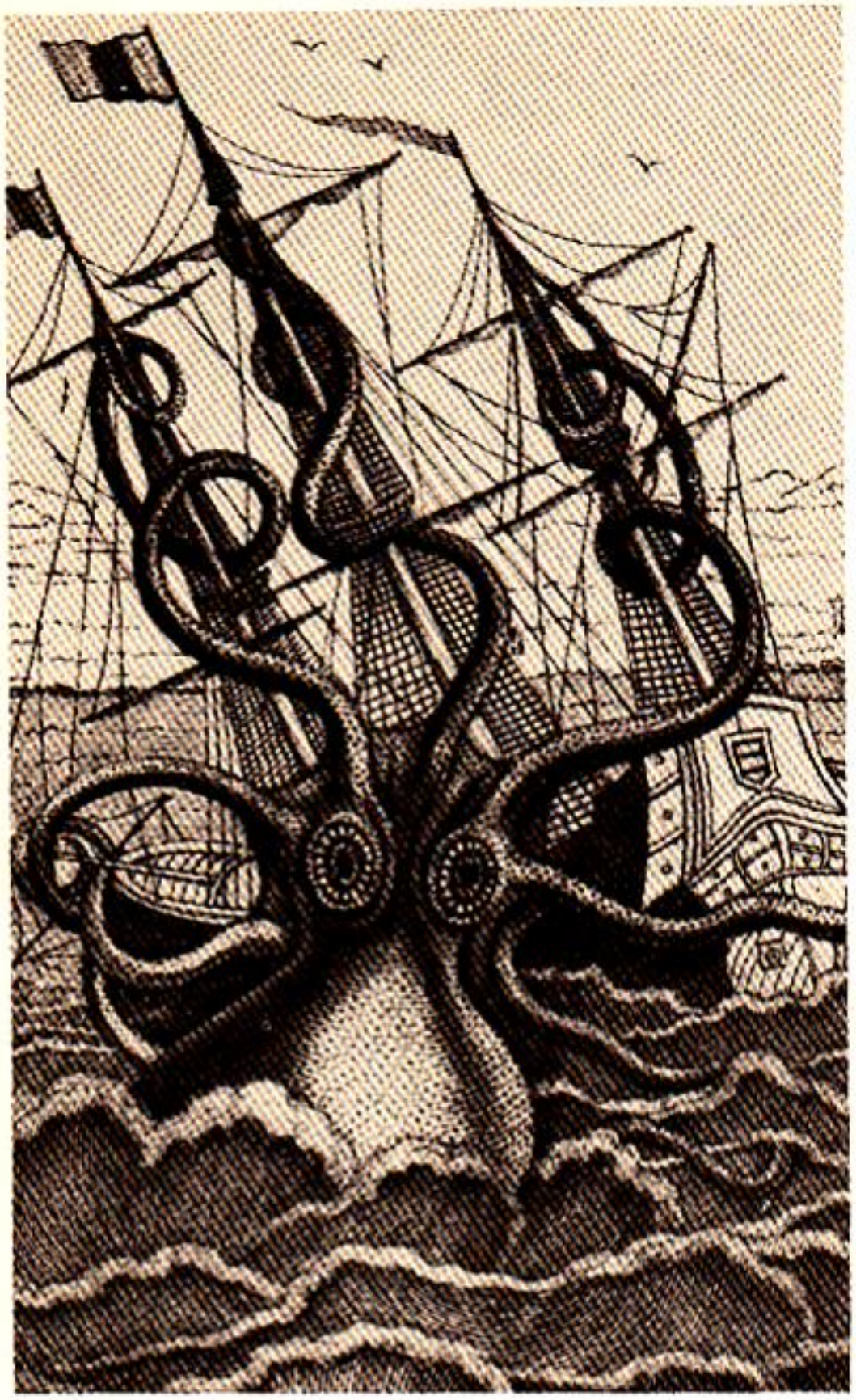
Then there was *Vityaz*'s deep-water trawl bringing up on ship-deck dozens of animals living at great depths which were previously unknown to zoology. Among them was the amazing deep-water fish pseudoliparis. This fish has no scales and its eyes are no bigger than a pin head.

But the remarkable pseudoliparis, as well as the no less remarkable white-blooded fish, the pygmy fish and the fish living in hot water pale before the gift the ocean presented to mankind in the shape of the latimeria, a fish of the order of fossil fishes Crossopterygii thought to have been extinct since the Cretaceous period. To begin with, the fish did not have this name, although zoologists knew about it. Its fossilized remains indicated that it lived on Earth 300 million years ago. It was known to palaeontologists as the coelacanth.

Two very important facts were known about the crossopterygian fish:



The coelacanth, "a living fossil", is the proof that persistence, courage and conviction win out in science.



Even as recently as in the 19th century people believed in monsters. An illustration from the book by de Montfort (1805).

A mermaid. An engraving from a book dated 1491.

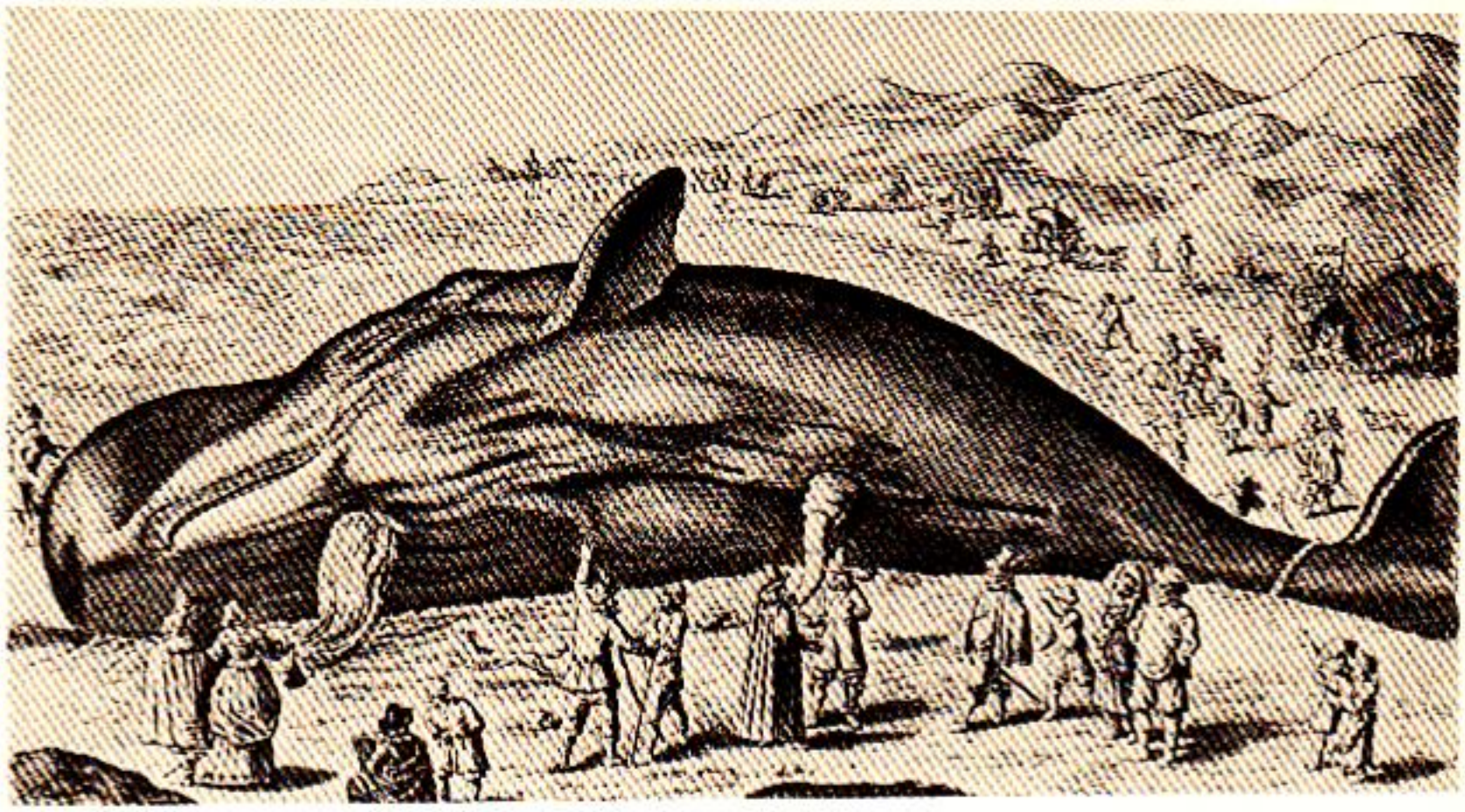
that all land vertebrates are traceable to them, and that they became extinct 50 or 60 million years ago. This firm and fully justified conviction would probably never have been disproved had not, on December 22, 1938, the telephone rung in the small museum of the town of East London in South Africa. The curator was informed by the caller that an unusual fish had been caught by a fishing trawler.

The curator, Miss Courtenay-Latimer, went down to the port at once. The big bluish fish, a metre and a half long, looked unfamiliar to her as well. But Miss Courtenay-Latimer realised that she was face to face with a discovery.

And what a discovery it was! It made the name of the modest woman-curator world famous. The prominent ichthyologist, Professor James L. B. Smith, who undertook to describe the fish and identified it as a living fossil, named it latimeria in honour of the first zoologist to see it.

As Professor Smith himself wrote later, the discovery of a living coelacanth was a real shock for the scientific world. It is not every day you find an animal you had believed extinct for the last 50 million years to be alive and thriving!

Palaeontologists have learned to reconstruct the appearance of prehistoric animals from their fossilized remains with a considerable degree of accuracy. They can imagine their internal structure and even habits. Sometimes they are lucky enough to find a bit of fur or skin which has been preserved in amber for dozens and hundreds of millions years. Such finds are a great help. Still, muscles, soft tissues, and brain — all these are irretrievably lost to palaeontologists. Imagine their



And imagine the food for fantasy that was provided by this sperm-whale, which was caught in 1577 in the mouth of the river Scheldt.

delight at obtaining a live fossil!

Moreover, the very fact of such an animal's existence in our time is amazing and all but incredible. Finally, the study of embryos of the prehistoric fish (and if it exists, then it must multiply, so it must be possible to get hold of its embryos) would elucidate many a dim page in the history of the origins of life on Earth.

In short, there were many reasons for zoologists to be excited.

Still, while some rejoiced, hoped and dreamed of important discoveries connected with the coelacanth, others were sceptical. Professor Smith's opponents argued that even if the fish really was what the professor claimed it to be, although he arrived in East London ten days after its capture and had to make do with its photographs, descriptions, and skin, even then it might have been the only one of its kind which had reached us by some miracle. If coelacanths really lived on Earth now, surely they'd have been caught by fishermen before 1938!

This argument did not shake Professor Smith's conviction, so he began asking the fishermen. It turned out that from time to time, fishermen did catch strange fish unknown to them. But there were never any zoologists on the spot, and the fishermen themselves were mainly interested in the gastronomic qualities of fish.

Professor Smith had special leaflets printed which provided a description of the fish, explained its scientific value and offered a reward to whoever caught a coelacanth. These leaflets were distributed among the fishermen. However, fourteen years passed before another coelacanth was obtained. Fourteen years of hopes and disappointments, fourteen years of struggle against the elements and men's disbelief. And finally — victory! In 1952, near the Island of Anjouan, in the group of Comoro Islands, the second coelacanth was caught. And within the next eight years another sixteen were taken!

No, there could no longer be any doubt that a fish with narrow, long and very flexible bases on its double fins, which enable us to understand how fins became extremities in land animals, actually exists in our time!

Having undergone no changes from prehistoric times, the coelacanth has adapted splendidly to contemporary conditions of life.

How did that happen? This is yet another puzzle which zoologists are called upon to solve.

There are many more puzzles as regards the coelacanth. For instance, why do the fish only occur near the Comoro Islands and nowhere else? How do they multiply? What is the texture of their muscle tissues? (Smith established that when the fish is boiled, its meat becomes almost liquid!) Latimeria has posed many questions for zoologists, and we do not yet know how many more it will pose and what will be elucidated when the answers to them have been found.

The Discovery of the Century

In 1958, the 15th International Congress of Zoology was convened in London. Major zoologists from all over the globe had come to the British capital. An international congress of zoologists is always an event in the scientific world, and this one caused great excitement. The Soviet zoologist Artemy Ivanov was to read a paper there. When Ivanov appeared on the platform, the congress participants rose and greeted him with a storm of applause. He had made the greatest discovery in zoology in the 20th century. This discovery had a long history.

In 1899 the Dutch expedition vessel *Siboga* conducted zoological research in the seas washing the Malay Archipelago. The materials the expedition brought back to Europe were not all studied at once, as was established by the French zoologist Maurice Caullery who was invited in 1914 to systematise them. Among the "trophies" left neglected were some long, thin pipes which contained some creatures unknown to science. Nearly fifteen years had passed since the return of the *Siboga*, and yet in all those years, nobody had paid these pipes any attention. Obviously the reason was that both the pipes and their residents were nothing much to look at. But Caullery, an experienced zoologist, saw at once that he was dealing with some very unusual creatures.

He studied the contents of the pipes thoroughly and published his findings. Though he was well aware of how unusual the creature was Caullery had too little to go on. He did not succeed in establishing the nature of the mysterious animal, but confined himself to describing it and giving it a name — siboglinum. The first part of this word derives from the name of the ship which had brought the creatures to Europe, while "linum" in Latin means "thread", "filament". Indeed, the animal, when extracted from the pipe, proved to be very long and thin, truly filament-like.

Caullery's small article went unnoticed and was soon forgotten.

Eighteen years passed.

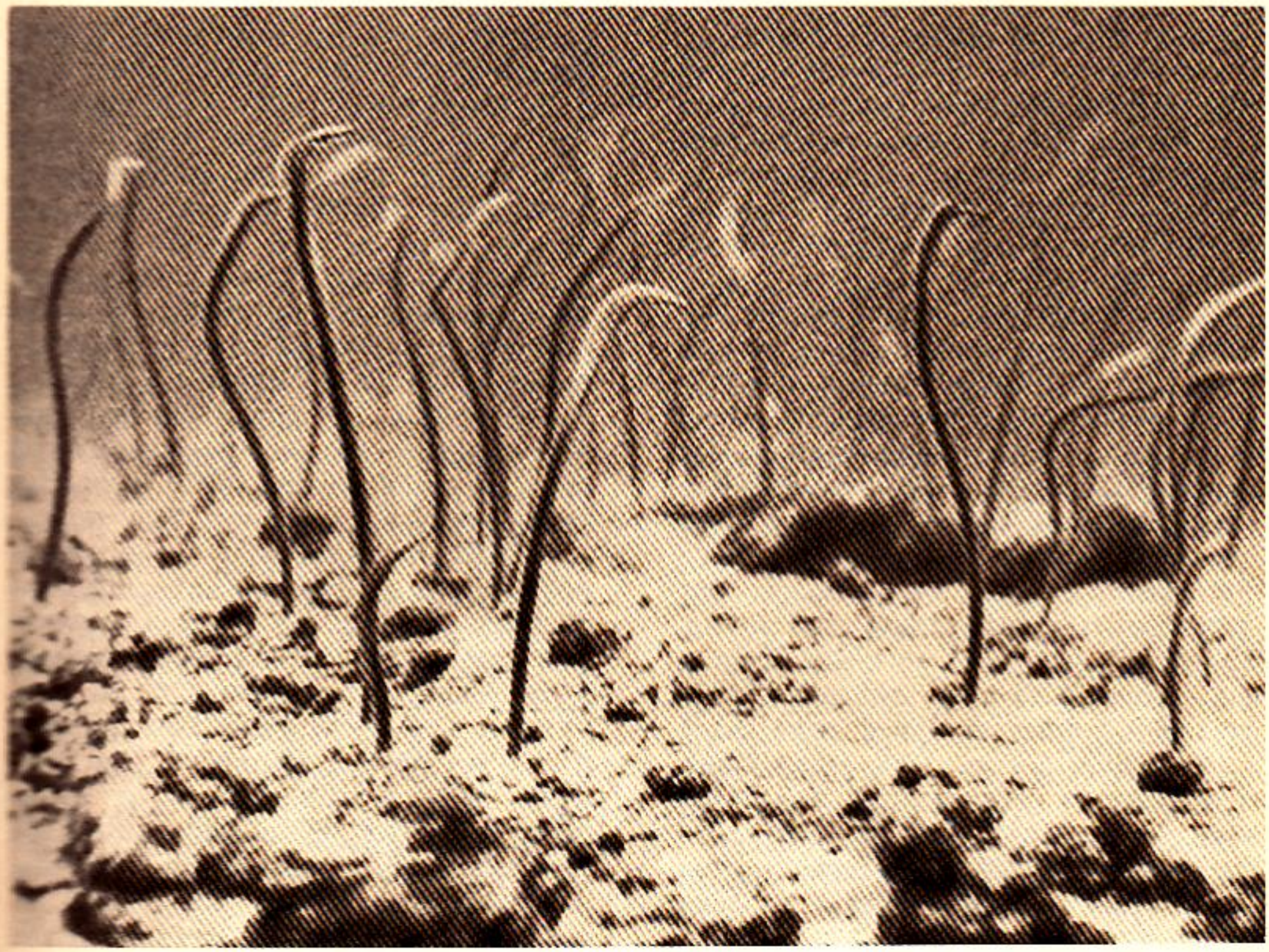
In the summer of 1932, the Soviet expedition ship *Gagara* was conducting investigations in the Sea of Okhotsk. On board was young zoologist Pavel Ushakov.

One day, the trawl brought up from a depth of three and a half kilometres several thin black-brown pipes some 15 centimetres long. Inside them were strange animals with a bunch of long feelers spreading out from the front part of the body. In a way they resembled the creatures described by

Caullery, but at the same time, they differed substantially from them. Besides, the siboglinums had been caught near Indonesia, and these animals were found in the Sea of Okhotsk. Ushakov decided that they belonged to the order of the *Polychaeta*, marine worms, some species of which live in protective pipes. The only thing that remained to establish was the place of the new animal among its brethren.

Ushakov decided to consult a prominent Swedish zoologist K. E. Johannson and sent him two of the creatures he had found.

Imagine the surprise of the zoologists when Johannson announced that the animal was not related to any worm whatsoever. Moreover, Johannson maintained that the creatures found by Ushakov did not belong to any of the known classes of animals. They were something entirely new. The Swedish zoologist named the creatures found in the Sea of Okhotsk pogonophores, from the Greek words "pogon" — "beard"



Nobody imagined (and not only in ancient times) that the most amazing creatures which man would ever discover are the pogonophores, plain-looking creatures which live in seas and oceans.

and "phoros" — "wearing". Their feelers did indeed resemble a painter's brush or a beard.

It was thus established that these animals represented a class all their own. Still, neither Johannson nor any other zoologists were able to define these creatures.

More than half a century had passed since the voyage of the *Siboga*. In 1949, a new Soviet research ship *Vityaz* was commissioned. It was a large handsome vessel of 5,600-ton displacement, with a powerful engine and first-rate laboratories. Artemy Ivanov took part in the *Vityaz*'s very first voyage. He was going in search of pogonophores. He had studied all that was known about them, having received Ushakov's materials from his own hands ten years before. But the answer to the riddle posed by them could not be obtained from those materials. Hence the expedition.

The *Vityaz* had many devices for catching marine animals, from powerful 12- and 22-ton winches, capable of winding 14 kilometres of steel cable, to various plankton nets for catching single-cell sea weeds, tiny crustaceans and larvae, and huge nets for deep-water fish. And of course there were trawls and dredges for collecting from the ocean bed fauna. The trawls, net sacks on heavy frames, and dredges, also sacks with even heavier metal frames equipped with sharp knives which dig into the ocean floor, were Ivanov's greatest hope. His hopes were not deceived — in the south-eastern part of the Sea of Okhotsk, in that very locality where seventeen years before Ushakov obtained his amazing creatures, the trawls again brought up pogonophores from a depth of 4,000 metres.

Soon siboglinums, too, were found in the neighbourhood. They did differ from pogonophores, having only one feeler, where pogonophores had a multitude of them, but still — Ivanov had surmised as much and now he was practically sure — they were one and the same animal.

But he did not have enough facts to prove it, so he continued to collect them.

Subsequently pogonophores were also found in other places, and finally the *Vityaz* found a veritable carpet of these creatures at a depth of a mere 150 metres.

Back from the expedition, Ivanov subjected the material he collected to a thorough study. Meanwhile, the *Vityaz* kept bringing him new samples from every trip. Now pogonophores were being found in many seas and oceans.

Ivanov himself went on several more expeditions to verify his conclusions, then headed back to his laboratory to do more painstaking work.

His study of pogonophores took several years. Finally the day arrived when he could tell the world in precise detail what kind of animal they were.

Should a skin come upon pogonophores on sea bottom, he would most likely overlook them. They are really very plain and uninteresting-looking. Their length varies from 5 to 35 centimetres and width from two millimetres to less than a millimetre. The thin, weak body is contained in a cylindrical protective pipe of horny substance secreted by the pogonophore. The pipe is always longer than the animal itself — from 20 centimetres to house the smallest pogonophore to 150 centimetres for the biggest pogonophore found to date. The greater part of the pipe

rises vertically above the ground, while the lower part is stuck into the slimy sea-bed. No, they are not beautiful, these pogonophores! Imagine a creature which can be as long as a large lizard and have the thickness of a pin! But appearances are often deceptive, and plain creatures often prove quite fascinating. This was certainly the case with pogonophores.

The filament- or cord-like body of a pogonophore consists of three sections. The first two are short and the back section is long. This last section houses numerous papillae with the help of which the pogonophore can move fairly quickly inside its pipe, now pushing part of its body outside, now hiding deep within it. The front section of a pogonophore has the "beard" — the bunch of feelers. There may be as many as a hundred, two hundred or more of them. There may also be only one. The fact is that in some pogonophores, the feelers grow together, the total number thus being reduced, sometimes to only one. The variety with one feeler was described by Caullery who called them siboglinums. This single feeler of the siboglinum and the "beard" of the pogonophores misled zoologists, causing them to believe that the two were very different animals.

However odd the outer appearance of pogonophores, their inner structure is weirder still. The filament-like body possesses well developed muscles, a spinal column, blood vessels filled with red blood and a heart of muscle tissue. What pogonophores notoriously lack is a stomach and an intestinal tract. Nor do they have a mouth.

We know of quite a few animals with no intestinal tract. Some of them are parasites which live inside another animal. But a creature living on its own and possessing no mouth and no intestines is something else indeed. Besides, pogonophores have feelers. What is their function then?

Corals, marine worms, and Polyzoa — all marine animals which have feelers — use them for catching food and placing it, through the mouth orifice, into the intestinal tract. But what do pogonophores have feelers for since they have neither?

It was established that in pogonophores, the feelers themselves act as both mouth and stomach. This discovery was at variance with all existing concepts about methods of feeding employed by various animals. Yet this is what happens.

The feelers of pogonophores are covered, on the inside, with long and very thin hairs which contain blood vessels joined to the larger vessels of the feeler. Hungry pogonophores stretch out their feelers, forming a semblance of a cylinder with slits, while the hairs inside the cylinder interweave, forming a thick net. (Those pogonophores which have but one feeler, coil it into a spiral.) As water passes through this cylinder or spiral, small organisms are caught in the net. When enough food — infinitesimal plants and animals — has been accumulated in the net, the pogonophore withdraws deep inside its pipe and begins to excrete a digestive enzyme which dissolves and digests the food. Once dissolved, the food is absorbed inside the body through the very same feelers.

The puzzle of pogonophores' feeding process had thus been solved. Still, the most amazing discovery was yet to come.

Zoologists know that an embryo, in its development, passes through stages at which it evinces a semblance to

its distant ancestors. These semblances disappear as the embryo develops and the grown animal may have nothing left of them. It was therefore extremely important to trace the embryonic development of pogonophores. But how could this be done? Usually pogonophores live at the depth of from two to ten kilometres. Very few species live in shallow waters. At this point, nature itself came to the aid of the zoologists. It was discovered that a female pogonophore lays her eggs in the top end of the pipe, while she herself withdraws to the bottom end. The eggs mature within the pipe until young pogonophores are hatched. Then they emerge from the pipe and settle around their mother.

So Artemy Ivanov began to select pipes which contained eggs and embryos at various stages of development. In the end, he succeeded in studying all stages of the pogonophore's development. Then another problem arose — how should these animals be classified?

A science-fiction writer endowed with lively imagination may think up and describe a most fantastic and astonishing animal. Still, from his description, if it is detailed enough, a zoologist can conclude to what known type the imaginary animal should be ascribed. The explanation is that the human imagination deals with concepts familiar to it. The fantastic animal may be composed of various assorted parts, but they will be parts already familiar to people — a head, extremities, wings, fins, etc. So an unknown animal will be composed of known parts.

But suddenly, an animal had been discovered which could not have been conceived by the wildest imagination. It had no legs, wings, fins, or even a head or intestines. So was it not a primitive animal? On the other hand, it had a heart, a spinal cord, a blood and nervous systems — sure signs of a higher organism.

How, then, was it to be categorised? It did not belong to any of the known classes, nor even to any of the known types of animals which have ever inhabited the earth. Pogonophores represent a completely novel type.

And that is not all. In order to visualise and demonstrate the development of life on Earth, zoologists have built up a genealogical "tree", with the roots represented by the protozoa and other most primitive organisms which started the development of organic life on Earth. As the animals become more complex, more and more "branches" were sprouted by the "tree".

However, all was not clear as far as this "tree" was concerned. There were gaps, and the most striking one pertained to the branch showing the development of some higher animals. Well, observations of the embryonic development of pogonophores demonstrated that they are close kin to that unknown creature which was the ancestor of many higher animals, including the vertebrates. In other words, the study of pogonophores adds to our knowledge about the distant ancestors of the vertebrates.

Thus pogonophores were the most momentous zoological discovery of the 20th century.

TO SUM UP THE PREVIOUS CHAPTER AND INTRODUCE THE NEXT ONE

We have thus established that the 20th century, the century of atomic energy and space flights, has also been marked by amazing discoveries in zoology.

To be sure, most of the discoveries have had to do with small animals. On the other hand, it was in the 20th century that the second largest ground animal after the elephant, the white rhinoceros, was discovered.

It was in the 20th century that giant monitor lizards and gorillas became known.

In 1957, Japanese zoologists reported the discovery of a new species of whale! The list of large animals formerly unknown to science had already exceeded fifty.

But on top of that, the 20th century has also been marked by re-discoveries. A striking example is the coelacanth or latimeria which was known to have existed on earth and become extinct 50 million years ago. And suddenly it was found to be living in our day and age.

No less interesting discoveries of supposedly extinct birds were made.

In the middle of this century, the American ornithologist Robert Murphy, while conducting zoological research on small islands lost in the Atlantic, found a nest with fledgeling he could not place immediately. The parent birds flying nearby in anxiety looked very much like the Bermuda stormy petrel, which was believed to have been exterminated way back in the early 17th century. It transpired that the bird had also been "resurrected" and built its nests on these tiny rocky islands. Robert Murphy found nearly twenty nests and also caught and banded several young birds.

Still more intriguing is the story of the takahe, an ancient bird which once inhabited New Zealand, also discovered after it had supposedly become extinct.

The bird, if not as ancient as the coelacanth, disappeared sufficiently long ago to have been missed by the arriving Europeans. It was only from tales told by the local inhabitants that they learned about this large, handsome bird which was a good runner but could not fly at all.

And then, in the middle of the 19th century, hunters chanced to catch

a very unusual bird: it had a thick crimson beak and sturdy legs, also crimson. Its neck, breast and sides were violet blue, while its head and throat were blue-black. Its back was olive-green, and its wings and tail dark blue. It was later established that this was the takahe, the bird which was believed to have become extinct several centuries before.

Later, several more birds were caught, but after that, no matter how hard zoologists tried, they failed to discover any traces of the takahe. They finally became reconciled to the idea that there were no longer any in existence.

But amateur naturalist Geoffrey Orbell continued the search for the bird. He launched two expeditions into the virgin mountain forests of New Zealand, and his efforts were rewarded. In 1948 the bird was "resurrected" again, in the region of Lake Te-Anau which is surrounded by heavily wooded mountains. Orbell found a whole community of takahes consisting of nearly a hundred grown birds and examined 30 nests.

More discoveries are made every year. Naturalists and travellers climb high into the mountains, penetrate impassable jungle, and descend to the ocean bed. Every year, nearly ten thousand new species and subspecies of animals are described in special magazines and in books.

It must be said that in actual fact much fewer new species are found, for zoologists often mistake small variations in an animal's structure for a sign of a new species.

One can understand a zoologist's joy and impatience at discovering a new species. Sometimes, however, the haste is motivated by a yen for sensation.

There may be another cause for mistakes — a lack of facts. It is not always possible to tell with certainty whether the new claim is mistaken or not.

In 1949, German zoologist Krumbiegel published a report on a new species or even genus of wolf. He had spent several years studying the skin of a strange animal. The skin had been brought from South America, and for a long time nobody could decide what animal it belonged to.

Krumbiegel compared the skin to those taken off other wolves, and studied skulls of wolves killed in the Andes where, according to the hunter, this particular animal had been killed. In the end, Krumbiegel felt he was justified in announcing the discovery of a new species and genus of wolf, the maned mountain wolf.

It is a risky business, however, to describe an animal on the basis of one skin and a skull alone (plus stories of eyewitnesses who had allegedly seen three other similar skins), and to claim a scientific discovery on this flimsy basis.

Dogs and wolves often crossbreed, and many zoologists averred that Krumbiegel's maned wolf was nothing but a dog gone wild.

Only time can decide the issue, and the question of the discovery is so far pending. If a live animal of the species described becomes available for

study, then it will be elucidated whether it is an ordinary wolf with a rare coat, a new species of wolf, or really a wild dog.

Time will bear out the correctness of some or support the scepticism of others, but there is no excuse for intentional falsification. Persons who engage in this practice often have academic degrees and honorary titles and descend to falsification for other reason than attracting attention.

The German Nazis claimed theirs was a special, higher human race, which was destined to rule all others. Naturally, such a race could not have a common ancestor with non-Aryans, so a special ancestor was required.

The theorists of racism were in luck. In 1922, the fossilized molar of a prehistoric anthropoid ape was found in the United States. While anthropologists expressed their puzzlement — for no anthropoid apes had ever been found in America, a theorist of German racism, Franz Koch, announced that this ape was the ancestor of the Aryan race.

Soon, however, the scientific world learnt that the molar actually belonged to a fossil boar.

"The ancestor of the Aryan race is now known to be a fossil North American pig," Soviet anthropologist M. F. Nesturkh wrote mockingly.

But the would-be falsifiers of science, seeking to prove men's innate inequality, were not discouraged.

It is a known fact that man appeared fairly recently on the American continent, not more than 25 thousand years ago. The first human inhabitants came from Asia, for during the Ice Age, Alaska and Chukotka were joined together, and this isthmus was used by the ancestors of the American Indians.

This explanation, however, does not satisfy the racists: if the Indians' ancestors had come to America from elsewhere, then they must have a common ancestor with Asians and Europeans. Anthropologists might next claim that Africans are also white people's equals! No, it had to be proved, at least to the satisfaction of the man in the street, that this was not the case!

Again, the racists were in luck. A large monkey was killed in South America. Somehow or other its skin and bones were lost, but a photograph remained. On the basis of this photograph alone, Professor G. Montadon declared that anthropoid apes had lived on the American continent, and hence the American Indians had a different ancestor than the Europeans.

Again, this was done to demonstrate that people living on earth were not equal, that some had the right to rule and others had to be their slaves.

The preachers of racism and colonialism stoop to actual forgery, producing photographs of non-existent animals to support their untenable ideas.

It is not, therefore, every report about the discovery of a new animal that should be believed. Mistakes occur out of haste, desire for sensation, insufficiency of facts, and some, finally, are made intentionally to falsify facts. A few of the mistakes which have been made border on the anecdotal.

Monster snakes were reported to have appeared in a small lake situated in the vicinity of the town of Eisenach, in the GDR. These monsters had been swimming on the surface of the water and many people had seen them with their own eyes. Some even shot at them, but the monsters seemed unharmed.

In the end it was established that the "monster" was formed of an immense number of carp fry that had bunched together to form the likeness of a huge snake 5 or 6 metres long and almost half a metre thick.

Such an accumulation of animals, particularly insects, is not a rare occurrence at all. In forests, one may meet "huge snakes" consisting of caterpillars; frogs sometimes gather in immense numbers, and cases have been known of large masses of newts. A person catching sight of such a "snake" from afar will naturally hesitate to come closer to investigate. In this way a legend is born. Before long, all kinds of fantastic details and embellishments are attached to it.

Of course such stories engender a sceptical attitude towards reports by discoverers of unknown animals.

And yet the record of our century proves that in the final analysis, romantics and enthusiasts win the day more often than sceptics.

Would we know about the latimeria if Professor James L. B. Smith had not been firmly convinced that it existed? Sceptics urged him to abandon his quest, saying that it had become extinct millions of years ago. But Smith, firm in his belief, spent 14 years searching, until he finally found the prehistoric coelacanth.

Would people ever have discovered that the takahe, a bird believed extinct or exterminated many years ago, is to be found, hale and hearty, in New Zealand's inaccessible forests if not for the persistence of passionate naturalist Geoffrey Orbell?

And what faith and stubbornness was required of Artemy Ivanov to make a thorough study of pogonophores and thus father the biggest discovery in zoology registered in the 20th century!

I could name hundreds of enthusiasts responsible for momentous discoveries.

Of course, mistakes occur. But there could be no progress in science and no discoveries at all if an attitude of extreme doubt were adopted by all and no ardent enthusiasts remained.

Professor Smith was quite right in saying that every scientific definition or theory must be preceded by the modifying words "As far as we know today..."

For we know far from everything. And the romantics and optimists among zoologists are continuing their search for new animals.

IT IS BETTER TO ADHERE TO A THEORY THAT MAY SUBSEQUENTLY PROVE TO BE WRONG THAN TO HAVE NO THEORY AT ALL.

D. I. Mendeleyev

4

Man Believes, Doubts and Seeks

Does the Tatzelwurm Exist?

Sixty people answered this question in the affirmative and supplied a description of this animal.

Here are some of the data supplied by eyewitnesses.

Size — from 60 to 90 centimetres. External appearance: a cylindrical body, a thick tail, big head and protruding eyes. Colouring: a brown back and a lighter belly.

Thus far, all sixty eyewitnesses were in agreement. But there were discrepancies as well. Some said that the mysterious creature had four tiny legs; others had not noticed any legs. Some said the animal was covered with scales, others said there weren't any scales. But these are details that could easily have escaped notice. The important thing was that the question asked by a Swiss newspaper about a mysterious animal was answered in the affirmative by sixty people who claimed to have seen a tatzelwurm with their own eyes. In addition they maintained that it hissed like a snake and had a fierce temper, attacking "on sight".

Rumours and legends about a mysterious and very fierce animal have long been current among the mountain folk of the Alps. But rumours cannot be regarded as scientific data, and these were sadly lacking. Different people living in different localities, without prearrangement, described the legendary animal similarly. This alone gave grounds for credence. It had a name, too, tatzelwurm, which means "worm with legs" in translation.

Stories alone were clearly not enough, at any rate as far as the sceptics were concerned, but there existed yet another proof of the actuality of this animal: its photograph. It was taken quite accidentally by a photographer for an illustrated magazine who went into the mountains in search of some interesting nature studies. Deciding to photograph a weirdly shaped dead tree, he trained his camera on it and suddenly saw a bough move. The photographer took fright and ran away, but not before pressing the button. When he developed the film, he saw an amazing creature, something in the nature of a big fish and with a very ferocious air about it in the words of the Belgian zoologist B. Heuvelmans.

This accidental photograph was published and produced a strong impression not only on zoologists. The newspaper which published the photograph even sent an expedition to the locality where it had been taken. But bad weather interfered with its work, and no tatzelwurm was caught.

The sceptics stood their ground: very well, they said, perhaps tatzelwurm really exists. But who said it was as big and poisonous as eyewitnesses claimed? After all, if one were to believe the description, it was a kind of lizard. Who had ever seen a poisonous lizard? But in fact, poisonous lizards do exist. The family's Latin designation is *Heloderma*. The bite of the beaded lizard of this family is lethal for small animals and even dangerous for man. Fatal outcomes have been known. The poison acts very much like a snake's, causing paralysis of the lungs.

The best-known animal of the family, *Heloderma suspectum*, is known locally as the Gila monster. It is fairly big as lizards go, up to 60 centimetres long and outwardly is very similar to the description of the tatzelwurm. The same may be said about other species of *Heloderma*.

Heloderma live in the deserts of

The Gila monster, a supposed kinsman of the mysterious European tatzelwurm.

Mexico and the adjacent territories of the United States. There are two species there, *Heloderma suspectum* and *Heloderma horridum*, and a third, *Lanthanotus*, lives on Borneo.

Yes, but not in Europe! That's right, no European species of *Heloderma* are known. Or, recalling Professor Smith's injunction, as far as we know today there are no *Heloderma* in Europe. But there may very well be, all unknown to us. After all these lizards used to live in Europe. That much we do know; and they existed in other parts of the world as well. Of course, today they only live in Mexico and on Borneo. But is it so impossible that some should have been preserved in Europe as well?

Sceptics may inquire why no one has ever seen them. True, nobody has seen *Heloderma*. But many have seen the tatzelwurm. What conclusion is suggested?

Australian naturalist, Doctor Nicolussi, is firmly of the opinion that the tatzelwurm is a special species or genus of the family of *Heloderma*. He has even given it a tentative scientific designation, *Heloderma europaeum*. Time will tell whether the Australian zoologist is right or wrong. But it all goes to say that animals unknown to science can be discovered in Europe as well as in the impenetrable jungle of Africa or America.

The Mystery of Rivers and Lakes

Anacondas are among the biggest snakes on Earth. They live in South America and are believed to reach an average size of 5-6 metres. Sometimes giant anacondas occur, reaching all of 10 metres, and once in Eastern Columbia, the largest anaconda ever, ll metres and 43 centimetres long, was caught. Many zoologists believe that this is the maximum an anaconda can grow to be, and they also believe we know practically all there is to be known about the life and habits of this mammoth snake.

But there are some who doubt it.

The first person to sow seeds of doubt in the minds of zoologists as regards anacondas was Colonel Percy Fawcett of the British Army who was sent to South America by the London Royal Geographical Society to verify the frontiers of Brazil, Bolivia and Peru. There, in the tropical jungle, at the beginning of this century, Colonel Fawcett was the first European to hear tales about a giant snake. An anaconda five or six metres long is a very big snake. A ten-metre-long anaconda is a real giant. But eighteen metres would tax anyone's credulity.

Colonel Fawcett did not believe the hunter who told him he had killed an

The toad may also have kinsmen not yet known to science. Is that why it looks so haughty?

eighteen-metre-long anaconda. In the first place, the story contradicted all available data; in the second, the hunter might simply be telling him another of the tall stories hunters the world over are famous for; thirdly, stories about fantastic snakes are generally current among the American Indians. After all, even the Indians' distant ancestors, the Aztecs, worshipped a "winged serpent", while the ancient inhabitants of Bolivia and Peru worshipped another fantastic serpent they called Amar. Perhaps legends about huge serpent-like monsters passed down by word of mouth from generation to generation were simply being repeated by present-day Indians?

Colonel Fawcett was not a serpent-worshipper and did not give credence to the story of a monster-sized anaconda. But he had to change his mind before two months passed. The reason for this was the nineteen-metre-long anaconda he killed with his own hands.

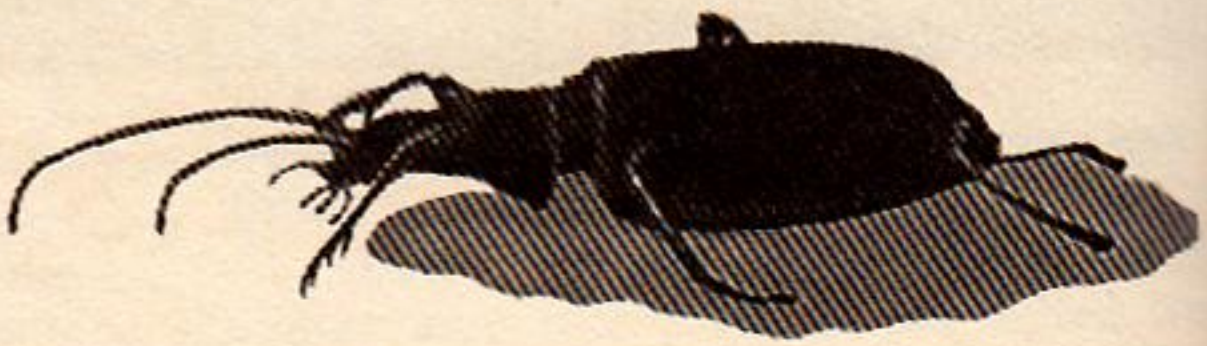
But if Colonel Fawcett came to believe in monster snakes, his word was disbelieved in Europe. He was even called "an impudent liar".

However, what seemed crass invention to many European zoologists was plain fact to South American populace, as well as to some travellers and explorers.

Reports were arriving in Europe based on stories told by the Indians and the testimony of explorers about meetings with truly mammoth snake-like creatures. They had been seen in water and on dry land, devouring wild boars and caymans, they had even been photographed and killed.

The first photograph was made in 1933. A mammoth snake reared out of the water some 8 or 10 metres beside an army post, striking fear into the hearts of the soldiers. It was killed with a machine-gun. It was so big and heavy that four men barely managed to lift its head.

The second mammoth snake was killed fifteen years later also in the vicinity of an army settlement and also with a machine-gun. It was asserted, although it is hard to believe this assertion, that its length was nearly 35 metres. But even if its terrified killers added some 15 metres, an anaconda



Even the most observant and keen-sighted of men will not catch the moment when a toad disposes of a beetle: the whole hunting operation takes no more than several tenths of a second.

20 or 25 metres long is a stupendous monster.

So much data had been gathered about the giant anaconda, and they appeared so persuasive, that Lorenz Hagenbeck, son and follower of the famous Karl Hagenbeck, decided to send a special expedition to South America. Not, naturally, to catch the giant anaconda. In Lorenz Hagenbeck's view, this snake could be up to 50 metres long and would weigh no less than 5 tons. It did not appear possible to catch such a creature, and even if this were done, how could it be transported and where was it to be kept? The biggest aquarium on earth wouldn't be large or strong enough for it.

No, Lorenz simply wanted to film a hunt of the monster and, consequently, see the giant reptile on the screen.

The expedition sent by Hagenbeck was a failure. But some time later, Rolf Blomberg, a Swedish expert in capturing and filming animals set out for South America. He brought back to Europe both anacondas and a film about hunting them. But he found no mammoth serpents, though he made a lot of inquiries. He checked numerous stories, measured anew the skin of a supposedly 12-metre-long anaconda, which proved to be merely six metres long and got in touch with a museum reputed to have obtained an 18-metre-long skin, but the museum denied the rumour. Almost all the reports that he had been able to verify proved exaggerated. Finally he set a reward for the skin of a giant anaconda. Nobody claimed the prize, just as nobody came forward to claim an even bigger reward — 5,000 dollars — offered by the American President Theodore Roosevelt for any anaconda skin in excess of 10 metres. Nor did anybody react to the promise of 10,000 dollars

made by the New York Zoo. So Rolf Blomberg came to the conclusion that the mammoth anaconda was a figment of the local hunters' imagination.

However, Blomberg was not the last man to go in search of a giant anaconda. Many more enthusiasts followed. One of them was the French journalist Olivier Pequet. He spent six months in Amazon jungle of Bolivia, searching lakes and wading through almost impassable marshes. He never saw a giant anaconda, but he accumulated a lot of stories and eyewitness accounts and legends about the monster snake.

Witnesses defined the giant creature as an anaconda. The shape of its body, the colour of its skin, the method of locomotion in water and on dry land left no room for doubt. Only two details made one wonder. All the witnesses to a man described the creature as having huge luminous eyes, while an anaconda's eyes are so small they are difficult to find at the tip of its nose. Besides, the giant reptile was reputed to possess huge fangs which stick out of its mouth, while a medium-sized anaconda has teeth that are only visible if you open its mouth and bend its head backwards. On the other hand, fear makes you see things, and these details might be ascribed to the witnesses' paralysis of mental faculties.

Olivier Pequet arrived at the conclusion that the stories about monster serpents did not all refer to one animal, but at least to two — a giant anaconda and another animal unknown to zoologists which the local population call minkao.

Nor is Olivier Pequet alone in his conclusions. Many zoologists are certain that the South American rivers, lakes and forests hold many a secret.

But is such a monster reptile possible in principle?

At one time, gigantic snakes did live on Earth. This is borne out by the discovery of a huge snake fossil in Egypt nearly 20 metres long.

Yes, but the snake has been long extinct, some may object.

But the coelacanth was considered extinct not so many years ago, others may argue.

But the giant snake skeleton was found in Africa and the anaconda lives in South America, the sceptics may argue.

However, does not the existence of *Helodermas* in America and on Borneo prove that similar animals may live at a great distance from each other, the romantics will repartee.

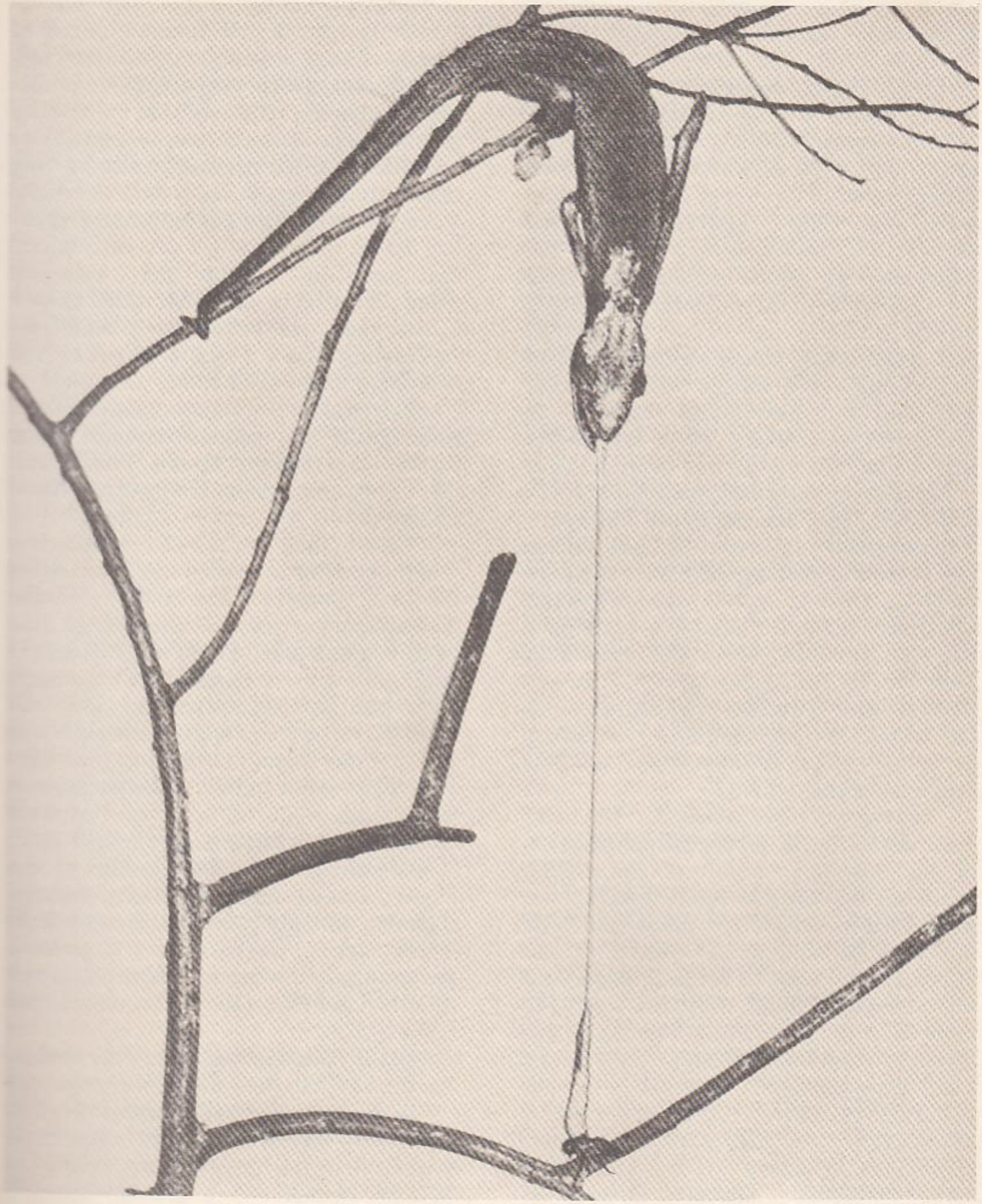
So... Well, it's too early to draw conclusions. Up to this point zoologists have just been amassing facts.

These facts snowball. And they do not arrive from South America alone.

As soon as explorers began to penetrate the depths of Africa, they were inundated with stories about amazing creatures inhabiting the rivers and lakes of this country. They had a multitude of names: "lau", "shipekwe", "lipata", "mokele-mbembe", "ailali", "badigui", "ngou" and many others. All these legendary animals had one feature in common — they lived in water, were huge in size, had a snake's head, and according to many reports, also a snake's body.

Most zoologists, overwhelmed by the avalanche of legends and stories, dismissed them indiscriminately as sheer invention. Yet the legends persist, and it may very well be that new information will force the zoologists to take a closer look at Africa's legendary creatures.

Information about unusual animals



Each hunts in his own way. This lizard prefers to obtain food by this method.

has even come from outlying regions of our own country.

One of the first such reports came from Valentin Akkuratov, navigator of the Arctic Board of Civil Aviation.

In August 1939, Akkuratov was returning to base with a well-known arctic pilot, Ivan Cherevichny. Below them was what Akkuratov described as water lace — countless lakes. The plane was flying quite low and they could see the earth in great detail. Suddenly on the shore of one of the lakes, they saw huge black gleaming bodies. They first thought the bodies were those of walruses! But how could walruses be found on the shore of a freshwater lake a hundred kilometres from the sea?

Moreover, walruses never grow to be six metres long, and the pilots had a sure eye, and their judgement of land objects was quite accurate. And another thing — the animals had spindle-shaped bodies and long necks quite unlike walruses'.

The pilots contacted Corresponding Member of the Academy of Sciences V. Vize and Professor N. Zubov and told them of their discovery. Neither, though, could tell them what animals they had seen.

Fourteen years passed. In the summer of 1953, a geological expedition of the Siberian branch of the USSR Academy of Sciences found itself in the same locality where the pilots had seen the unusual animals. The head of the expedition, Victor Tverdokhlebov and a technician Boris Bashkatov, made their way to Lake Vorota and saw the mysterious monster with their own eyes. The geologists assessed its length at about 10 metres, noted the general silver-grey colouring, a crest or a fin sticking out above water and even observed big eyes set at a distance of about a metre and a half and white spots on the head. Some hundred metres from the shore the animal stopped, thrashed about in the water and disappeared.

Tverdokhlebov's report, while amazing zoologists, did not at all come as a surprise to local inhabitants. They had known about the monster for a long time. It appeared only not in Lake Vorota but in the neighbouring Labynkyr Lake. The local people maintained that once the monster had swallowed a dog. On another occasion, it had chased a fisherman, and it had often been seen swallowing ducks which alighted on the surface of the water.

However, a special commission found no trace of any unusual animals living in the lakes Labynkyr and Vorota and no signs indirectly indicating their existence.

What then had Tverdokhlebov seen? And what about the stories of the local people? The Soviet zoologist A. Yablokov conjectured that it had been a giant pike. Pikes several metres long and with a head almost a metre wide had actually been found in the nearby rivers. Very well, perhaps it was a pike, especially since the local inhabitants know that pikes sometimes grew to be really huge (although not as huge as that). Such pikes are called "bulls". One of the lakes in the foothills of the Urals, located in a wild, unpopulated region, is actually called Varchato which, in translation, means "lake populated by monsters". These "monsters" are usually huge fish, two or three times the regular size.

Giant fish also occur in other lakes.

But are fish the only monsters going?

In the last century, Professor N. Kashchenko discovered and described a giant frog he found near Tomsk in Siberia. He gave it a special name — *Rana florinski*.

Was it merely a freak, or perhaps...

Nobody can assert with any degree of certainty that unknown giants do not actually inhabit our rivers and lakes. But science insists on irrefutable proof and facts that can be checked and re-checked. Even the existence of the famous Nessie is disputed by many, although plenty of facts seem to confirm it.

The Mystery of Loch Ness

It appears people have known about this particular mystery for many centuries. The Roman historian Pliny the Elder heard about monsters living in Scotland, and they are mentioned in chronicles back in 561. But nearly fourteen centuries had to pass before people began to take a serious interest in those animals. And then, the obscure Scottish lake, Loch Ness, became world famous.

It all began in 1933 when road building started on the shore of the lake. The noise of tree-felling and dynamite blasting must have annoyed the animal, and it showed itself, thus giving new life to a legend which had remained dormant for centuries.

In May 1933, a married couple were driving in their little car along the lake. It was barely the break of day, and John MacKey, who was driving, was peering warily ahead. Suddenly he braked sharply as a dark massive object crawled across the road and splashed into the water.

Soon afterwards, on August 11, 1933, engineer A. H. Palmer was taking a walk along the shore. Suddenly...

"I wondered if a squall had suddenly struck, but not a leaf stirred on the trees. The surface of the lake was broken by a seething whirlpool about a hundred metres in circumference. At first I could not see any reason for it, then I saw a very long dark object that had risen from the lake's depth in its centre. I made for my car. An hour later I came back to observe the fascinating phenomenon. Suddenly I saw on the water's surface, a hundred metres from the shore, a flat head that was like an upturned bowl, black in colour. On both sides it had short protuberances that can be compared to a snail's horns. Between them was a mouth, 35-45 centimetres wide, that kept opening and closing at equal intervals of about 20 seconds. By the even breathing I concluded that the animal was resting afloat the water. It remained in this position for about half an hour, slowly drifting to south-east."

Palmer's story seemed to have opened the flood-gates. Within a few weeks, the monster was seen by hundreds of people, both singly and in groups. English and Scottish newspapers published reports in a continuous stream, some of them quite incredible. But if we discard the incredible and leave that which contains a semblance of truth, we come to the conclusion that in the course of several weeks after its "rendezvous" with Palmer, the monster appeared on the surface 118 times.

Forty years have passed since. In the course of them, Nessie, as the English and the Scots named the monster, has surfaced scores of times, allowing itself not only to be seen but even to be photographed and filmed. A huge number of eyewitness accounts have accumulated. On the basis accounts, Constance Whyte wrote her book *More Than a Legend: the Story of the Loch Ness Monster*, which contains numerous reports, photographs, drawings and legends.

Even more conclusive is the book by Tim Dinsdale, *The Loch Ness Monster*, which contains 400 observations and eyewitness accounts. More facts have emerged since the writing of the two books. In the spring of 1963, for instance, the monster surfaced 40 times. Again this was obviously caused by explosions near the lake, which Nessie seems to object to.

The available material provided sufficient data for some conclusions. The first to come up with a statement was the British intelligence service which announced that there was something in the lake that was "massive, dark in colour and shiny".

Subsequently a commission of scientists was formed. After making a thorough study of the available material, it decided that some animal lived in Loch Ness. If it belonged to an order unknown to science, it deserved to be studied. If it is known to science, it deserved to be studied nonetheless, because its size is unique.

The commission's conclusion convinced many but not all. Some zoologists continued to regard Nessie as a figment of imagination. But enthusiasts were intent on their search. Boats criss-crossed the lake, and planes flew low overhead day and night, but now that people were on the lookout for it, the monster refused to show itself.

It was decided that the noise frightened the animal, and it was hiding in the depths of the lake. The search is still going on. A special bureau has even been set up to study the phenomena observed at Loch Ness. The bureau organises expeditions and collects all reports that appear about the monster.

And these continue to arrive all the time.

A professor of the University of Chicago reported, for example, that he saw the denizen of the lake on its surface on January 4, 1969. He had been studying the monster for several years and had come to the conclusion that the animal was an innocuous sea cow.

A group of researchers managed to film "a moving object, whose nature cannot be ascertained". The "object" was swimming in the lake at a speed of 16 kilometres an hour.

Using a special electronic device other researchers discovered in the depths of the lake several mysterious objects (or live creatures) many metres in length which moved at a speed of 25 kilometres an hour and were capable of rising to the surface and sinking to the bottom very rapidly.

Not all expeditions bring back worthwhile results. Often days, weeks and even months pass when Nessie does not in any way manifest itself. But these setbacks do not dampen the Nessie lovers' enthusiasm. On the other hand, failures provide fresh food for derision on the part of Nessie's opponents. As a matter of fact both parties weild weighty arguments.

The opponents say that the most convincing proof of Nessie's non-existence is the fact of its elusiveness. How can such a big animal live in a relatively small lake, which is 38 kilometres in length and only 3 kilometres at its widest point, with a depth ranging from 152 to 229 metres. Nessie's opponents regard all eyewitness accounts as fabrications and the photographs and drawings as forgeries.

Nessie's defenders maintain that the fact that the animal has not yet been caught does not necessarily mean that it does not exist. The numerous witnesses could not possibly have agreed to give

one and the same description of a monster with a long neck and small head swimming in a vertical and not horizontal position. The photographs and drawings were made by different people at different times and from different vantage points, and yet there is a great similarity between them. Moreover, judging from them, Nessie looks like the prehistorical reptile, plesiosaurus, considered extinct these last 60 million years.

This sounds fantastic, but, on the other hand, the discovery of latimeria, which is the plesiosaurus's contemporary, shows that the possibility cannot be ruled out. As for the lake itself, conditions there cannot have changed much since prehistoric times when plesiosauri lived on Earth. That must be the explanation for the reptile's survival.

While zoologists carry on their argument, enthusiasts are making a thorough study of other Scottish lakes, for information has begun to arrive about monsters having been seen elsewhere in Scotland, particularly in the deep freshwater lake Loch Morar.

Several dozen eyewitness accounts have already been collected, among them one by lecturers of the University of Edinburgh. They all describe a creature some 30 metres in length with a hump and a small snake-like head. The search is going on, and there is every hope for a successful settlement of the argument in the near future.

The Mystery of the Seas and Oceans ("The Case of the Sea Serpent")

Imagine yourself in a huge auditorium that seats several thousand. In this auditorium, a session is to be held to decide the issue of the possible existence of the sea serpent.

All the seats are occupied. On the platform sits an eminent commission which is to hear the witnesses and the arguments pro and contra and to arrive at a decision concerning the sea serpent.

To the right of the commission sit those who deny the existence of the sea serpent or any animal that could resemble it. To the left are those who believe in it. There are quite a few zoologists in the group and a great many amateur naturalists, sailors, and fishermen.

The gathering, members of the commission, and experts to the right and witnesses to the left are wearing a great variety of garb in the manner of different climes and epochs, which is nothing to be surprised at, seeing that the dispute about the sea serpent has continued for many centuries. To make the position quite clear, the chairman of the commission gives a review of the history of this problem in his opening address.

Chairman. The legend of the sea serpent — let us provisionally call it a legend — dates back to ancient times. Manuscripts that have reached us indicate that as far back as 3,000 years ago, people believed in huge mysterious animals that lived in the sea. But we are not in a position to verify the source of those ancient legends. What we are concerned with are more recent accounts of the sea serpent.

It is believed that the sea serpent was "invented" by the Swedish cartographer and historiographer Olaus Magnus. In the mid-16th century he published a book in which he collected numerous stories and legends about it and which he illustrated with fantastic drawings. Magnus's contemporaries had no means of either confirming or

disproving his assertions. And even Konrad Gesner, who knew better than anyone else how easily sea monsters could be forged, believed in the existence of sea monsters. In his *Book About Serpents*, he not only quoted Magnus but even reprinted drawings from his book. From Gesner, information about sea serpents found its way into the works of other naturalists, accumulating new "truthful" details until it became utterly impossible to separate the truth from sheer invention. And even the publication in 1892 by Professor A. C. Oudemans in London of his book *The Great Sea Serpent*, which contained all the available information about the mysterious monster, failed to clear up the issue. The question still stands: do sea serpents exist or not?

Deputy chairman. Before we begin the discussion, I must provide a zoological reference. Sea serpents do exist. They are the reptiles which inhabit the tropical seas of the Pacific and Indian oceans. Their favourite haunts are coastal waters, up to 5 or 6 kilometres. We know of 48 species of sea snakes. All of them are poisonous, but the largest of them are barely three metres in length. Zoologists are well informed of the existence of these sea snakes, and we are not going to discuss them.

Professor Bernard Heuvelmans (Belgium), *sitting on the left.* I want to make another clarification. The animals we are going to discuss today are called "sea serpents" provisionally and have nothing in common with sea snakes proper.

Chairman. Thank you, Professor. Well, let us begin. Who will speak first? I must warn you that I shall only give the floor to those persons who have seen sea serpents with their own eyes within the last one hundred and fifty years.

Naval officers (Canada), *sitting on the left.* The time we shall be referring to is May 1833. At that time, we were sailing past the south-eastern coast of Canada, in the region on Halifax. Suddenly, at a distance of 150-200 yards from the ship, we saw the head and neck of some denizen of the depths which looked like a snake. Its head was raised high above the water and in swimming was thrown alternately forward and back, so that it was first high above the water then underneath it. The odd creature swam past our boat (which was only making about 5 knots)... We all stared silently at it for about half a minute. There could be no doubt that we were seeing a real sea serpent, which is usually considered to be a figment of sailors' imagination. Its head was about six feet in length, and the thick, loglike neck visible to us was about as long. They were dark brown in colour, almost black, with white stripes. We did not discern any other details.

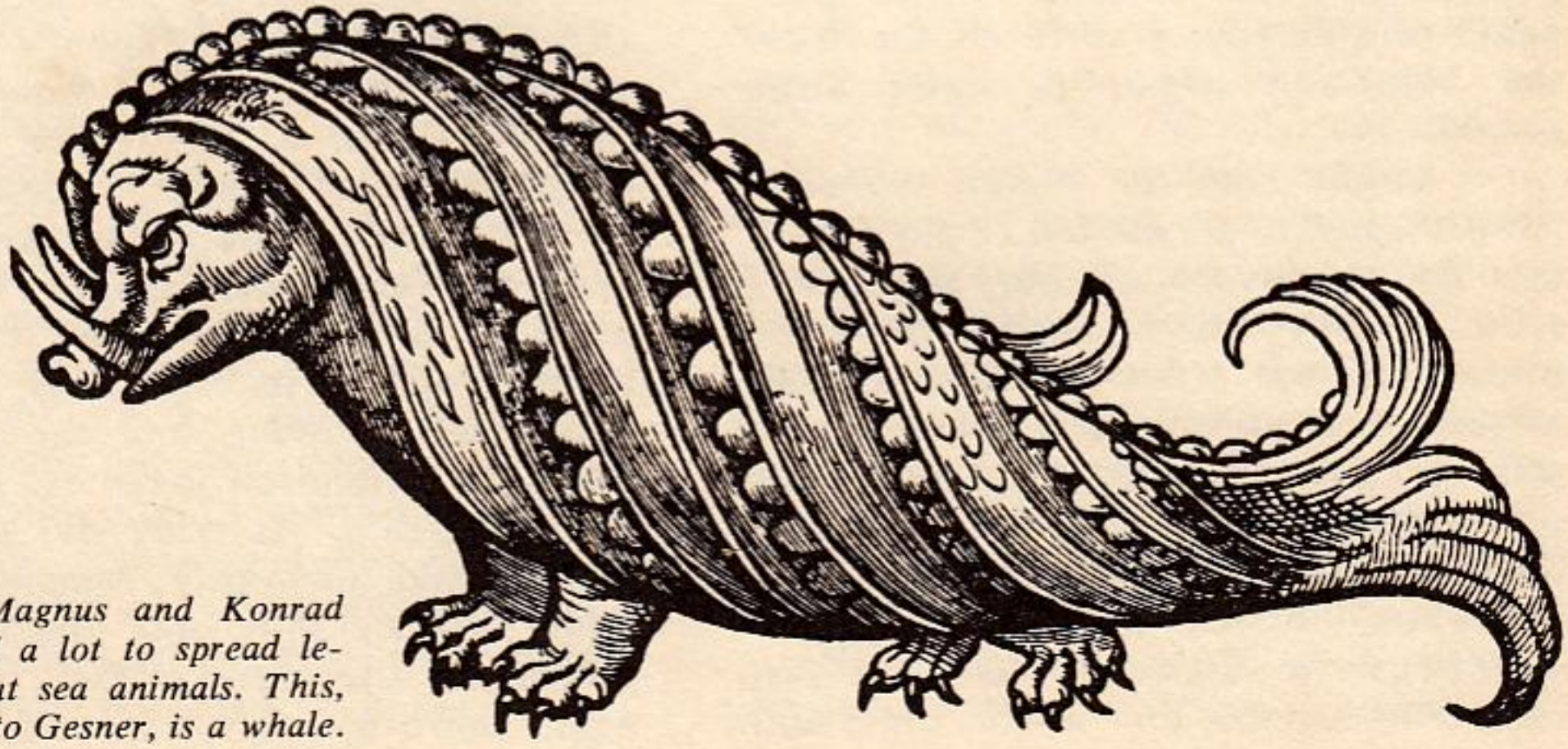
Peter M'Quhae, Captain of the frigate "Daedalus" (Great Britain), *sitting on the left.* In the autumn of 1842 we came back from India. *The Times* carried my report of the expedition in October of that year. I submitted a more detailed report to the Admiralty, where it is preserved in the archives to this day and where those who wish to do so can obtain and read it. I shall just read out to you the passage pertaining to the question we have gathered here to discuss.

"At five o'clock in the afternoon on August 6, 1842, the frigate was in the Indian Ocean. We were heading for the continent of Africa. I was taking a stroll on the quarterdeck with Lieu-

tenant Edgar Drummond when a panting midshipman ran up and reported that he had just seen through a telescope a strange creature which was quickly approaching the frigate from behind. We looked in the direction the midshipman was pointing and soon saw the creature quite clearly. A huge thick snake was swimming among the waves, its head raised about three feet above the water. The monster approached the ship and swam past so near that if an acquaintance of mine were in its place I could easily recognise him with unaided eye. For several minutes we stared at the snake, and all this time it never once lowered into the water its dark-brown head, which was about two feet thick with a white necklace round the neck. The length of its body was some seventy feet. None of us noticed anything like fins, but something in the nature of a horse's mane, most likely a bunch of water-weeds, was waving on its back..."

Before the captain of the *Daedalus* was properly seated, *Professor Richard Owen* (Great Britain), *sitting on the right*, jumped up. I beg to disagree with Captain M'Quhae and the seven sailors who also saw the "serpent". Oh no, I do not doubt their truthfulness and do not suspect them of deliberate deceit. To be sure they saw a "monster". But what was it? I am convinced that it was a huge seal of the kind we call sea elephants. They sometimes reach 17 feet in length. It is my opinion that one of these creatures was carried into the Indian Ocean on an ice-floe, and when the ice-floe melted, the seal started to swim home. You never expected to see a seal in those waters and took it for an unknown monster. As for the size, the churning of the water caused by its swimming motion was taken for the continuation of its body. I said it, and I wrote it, and now I repeat: "It is easier to find proof of the existence of ghosts than of the sea serpent."

Peter M'Quhae, Captain of the



Albertus Magnus and Konrad Gesner did a lot to spread legends about sea animals. This, according to Gesner, is a whale.

"Daedalus", sitting on the left. My honourable opponent, I have already replied to you through *The Times*: none of us who saw the monster accept your explanation. "There can be no question of an optical illusion... Whatever it was, it was not a seal... I stick to my estimate of its length... It was supported by people used to reckoning the length and breadth of floating objects..."

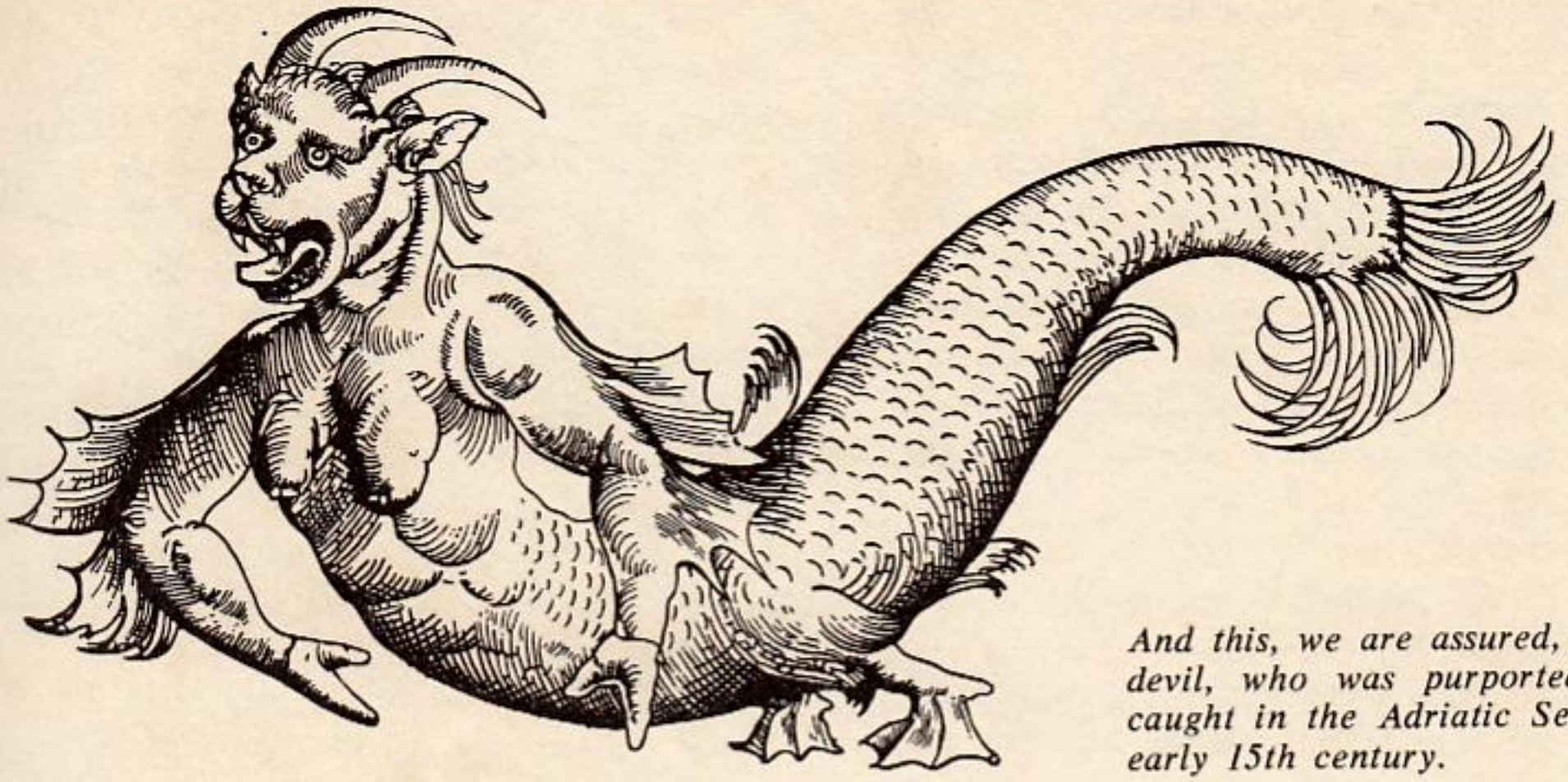
In the absence of the captain of the brig "Daphne" (USA), *a sailor of that ship, sitting on the left* asked for the floor. He told the gathering that shortly after the events described by M'Quhae, something very like it occurred with their brig. They also saw a giant snake. Their boat approached the monster and took a cannon shot at it from a distance of some 40 yards. The sailor produced the ship's log-book and read out:

"The monster jerked its head high above the water and, arching its gleaming body, dived into the depth. Apparently the shot hit the goal. The captain gave the order to approach the site where the water was churning and foaming. At times the animal appeared on the surface, then dived again and finally it surfaced far from the brig and began to swim away quickly..."

A sailor from the Indian schooner "Pearl", sitting on the left. I am one of the five survivors of our schooner's crew. My story can be supported by the passengers and crew of the steamboat *Stretowen* who witnessed the event. It was in the summer of 1874. Our schooner was caught in a dead calm. Suddenly some huge mass emerged from the water not far from the schooner and began to approach us at a fast rate. The captain shot at the mass and it fell on our schooner at once. The mass was so huge it capsised a 150-ton vessel easily. I and another 4 members of the crew were rescued by the *Stretowen.*

Captain Harriman, sitting on the right. I confirm this man's testimony that the schooner *Pearl* really did sink. But Captain Smith and I did not believe in any brown mass, nor do we believe in sea serpents. We elucidated the cause of the schooner's loss and informed the Indian newspapers accordingly. This is what we established and what we wrote about: "They were a mass of huge waterweeds, some hundred feet long and about 4 feet wide, covered all over with sea parasites, while the root sticking above the water had a semblance of a moving head." We actually fished out such a head...

Major H. W. J. Senior, passenger of the "City of Baltimore" (Great Britain), *sitting on the left.* Perhaps the *Pearl* was really sunk by huge waterweeds. But there can be no doubt that sea monsters do exist. I saw one with my own eyes. This can be confirmed by Miss Greenfield, the ship's surgeon Dr. C. Hall, and other passengers and members of the crew of the *City of Baltimore*. In January 1879, we were passing the Gulf of Aden on our way to India. Suddenly we saw the monster. This is how I described it at the time: "The head and neck, about two feet thick rose above the water some 6 to 9 yards. When rising the monster opened its huge jaws, and then closed them, diving into the water to reappear a hundred yards off the place of submersion. Its body did not show at all, and obviously remained deep under water, since no churning appeared on the surface. Only now and again there was a splash at some dist-



And this, we are assured, is a sea devil, who was purported to be caught in the Adriatic Sea in the early 15th century.

ance from the head, which reminded me of the known representations of the dragon. The face was a bit like a bulldog's. Before diving, the monster dropped its head onto the water like a log of wood. Then on both sides of the neck, spray flew up to a height of five yards, resembling wings in its shape..."

A member of the Linnaean Society (Boston, Great Britain), *sitting on the right.* The report of Major Senior is very interesting, but it suffers from inexactitudes. There is no telling what he saw. Let me give you an example. Long before the major saw his "monster", our society received many reports about sea serpents. In the end we decided to set up a special committee for the study of the "sea serpent". I was on that committee and know how seriously we approached the task. We heard testimony of people who had seen the "monster" with their own eyes. And we only accepted it under oath. Moreover, we developed a list of 25 questions a witness had to answer. These questions excluded all possibility of invention and deceit. And nevertheless we were an ignominious failure!

One day, a 3-feet-long humped monster was brought to us. It was purported to have been killed on the sea shore. We examined it carefully, especially the humps on its back since many eyewitnesses had mentioned the humps. In the end we came to the conclusion that this was a young cub of the sea serpent or some other unknown sea monster. We even gave it a scientific name — "Atlantic humpback" and published a drawing and a description of this monster. Imagine our discomfiture when we discovered it was nothing more than a grass-snake maimed by some disease! Remember, we examined it, not merely observed from ship deck!

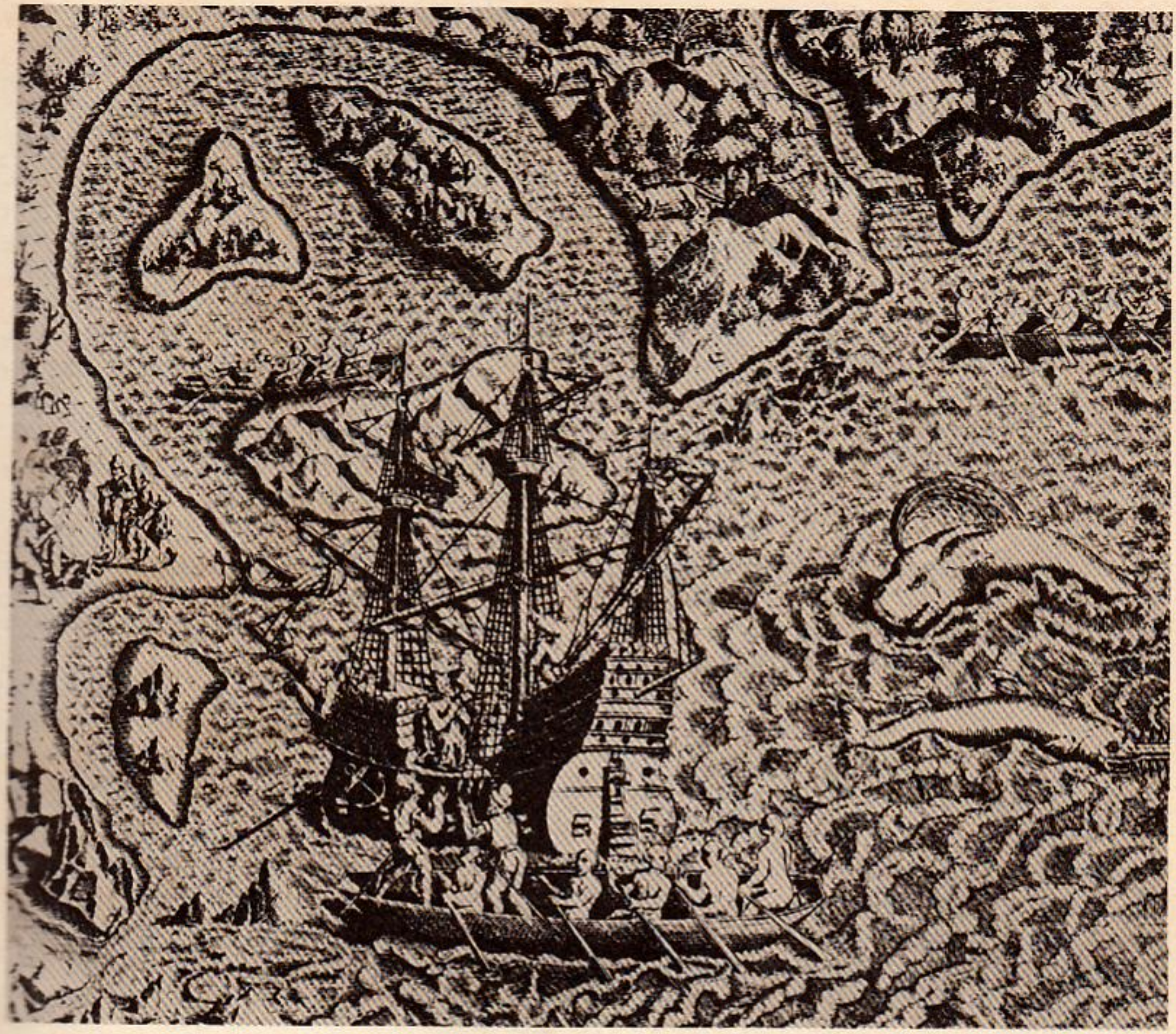
Officers and men of the man-of-war "Philomel" (Great Britain), *sitting on*

the left. We cannot account for the gross error committed by the respected members of the Linnaean Society. But we swear that on October 14, 1879, at 17.30 Greenwich mean time we saw in the Gulf of Suez a monster which could under no circumstances be a grass-snake, not even one maimed by disease. It had a dark-grey head with huge jaws, pink underneath and deepening into red nearer its belly. The monster rose out of water to the height of 5 yards and we could clearly see a fin on its back.

A zoologist specialising in sea snakes sitting on the right. I specialise in sea snakes, but real ones, not monsters. While listening to the dispute I remembered an amazing occurrence I once witnessed in the Strait of Malacca. It was a giant serpent. Its average thickness was 10 feet and its length ... dozens of miles. Had I not been a zoologist and a specialist in sea snakes as well, I would surely have taken the creature for a monster. But I soon realised what it was. It was a vast conglomeration of comparatively small sea snakes about 5 feet long, astrotias. I do not make bold to deny the existence of the sea monster, nor do I assert that it exists. My purpose is simply to point out that neither of the people who have spoken so far were zoologists. Had they seen this vast conglomeration of astrotias, they might have taken it for a serpent.

Zoologists M. J. Nicoll and E. G. B. Meade-Waldo, members of the Zoological Society (Great Britain), *sitting on the left*. We quite agree with our colleague sitting on the right that non-specialists are liable to make mistakes. But we consider ourselves specialists. This is what we wrote in the Minutes of the Zoological Society in June 1906 about the monster we observed near the coast of Brazil: "On December 7, 1905, at 10.15 hrs a.m., we were in the stern of the yacht *Valhalla*. Suddenly some hundred yards from the yacht, a strange object appeared on the surface. It was a huge fin sticking out above the water. Its colour was dark brown like the colour of seaweeds, it was slightly wrinkled at the edges, its length was about six feet and it rose some two feet above the water... In front of the fin, out of the water emerged a huge neck and a head. The neck did not visibly join the fin but stuck out of the water two feet or more in front of it. The neck seemed to have the thickness of a human body and it rose above the water to the height of 7 or 8 feet. The head of the monster resembled a turtle's and there was a brown mane on its neck. At first the monster swam parallel to the boat then overtook it, raising a wave which interfered with the observation. And when the animal dived, a breaker rose and spray flew up high into the air. Almost the entire crew saw the animal and can confirm the truth of our words. Besides, it must be taken into account that we are zoologists and would be unlikely to mistake some other animal for a sea serpent."

Zoologist Alfred Newton (Great Britain), *sitting on the right*. I have often observed Greenland seals. These animals often swim in a file, one after another, and one or another of them will leap out of water now and then. As I watched such a file, I could barely shake off the impression that it was a giant sea snake — the seals produced a perfect semblance of one. The leaping animals add to this impression of a weaving snake's body. I wonder



This old engraving represents a mixture of men's real and fantastic notions about animals.

if the legend about the sea serpent did not originate with a herd of swimming Greenland seals.

Captain Georg Günther von Forstner, a "U-28" submarine commander (Germany), *sitting on the left.* I cannot agree with Mr. Newton for the simple reason that I saw an unknown sea animal with my own eyes and it did not in the least resemble a Greenland seal. This is what I wrote in my report: "On the July 30, 1915, we sank the large British steamer *Iberian*... The steamer sank very rapidly, stern first,

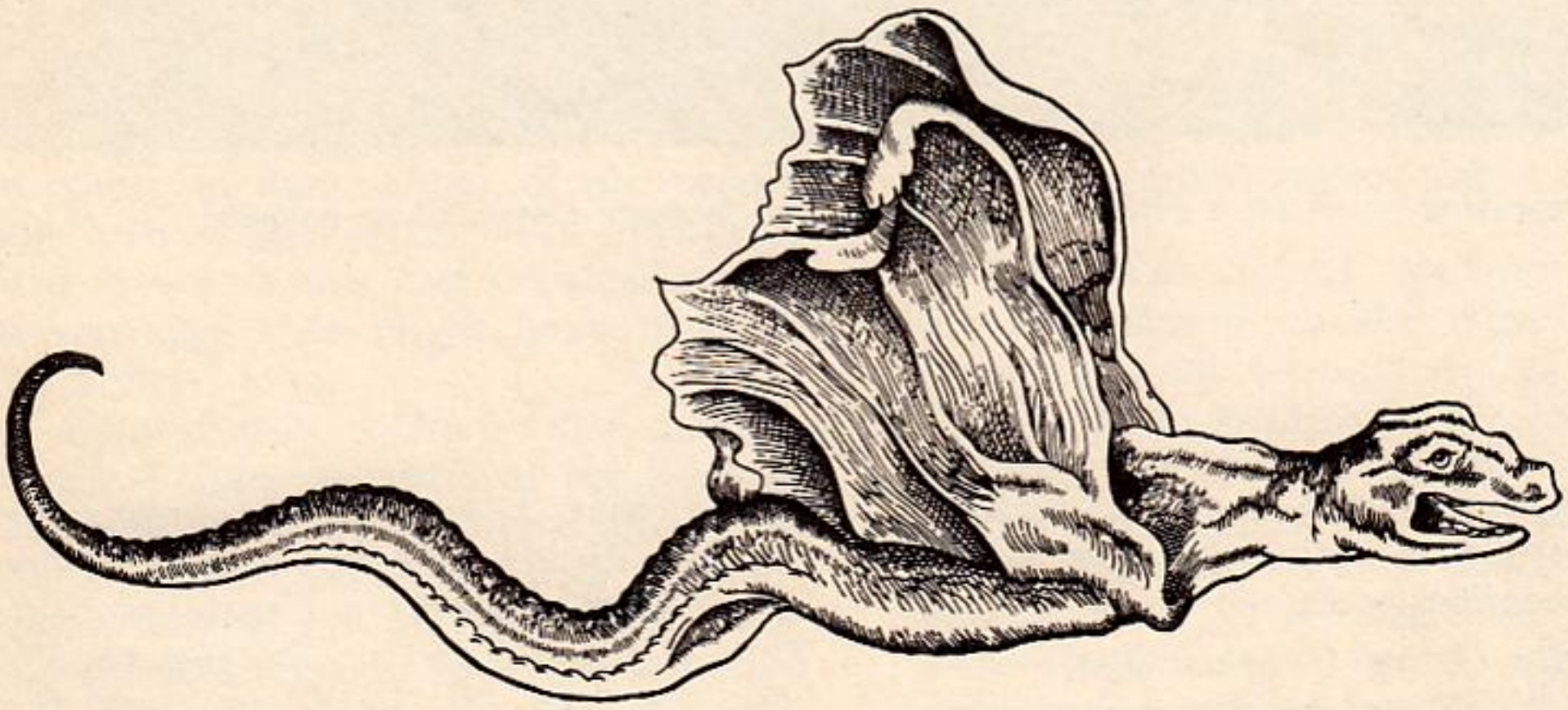
with her bow almost perpendicular in the air. A short time — at least 25 seconds — after she had completely disappeared, a moderately loud explosion took place under water. Immediately, some pieces of wreckage were thrown into the air — and among them, to our astonishment, was a gigantic marine animal, foundering and kicking...

"The creature had a long tapering head and a long body with two pairs of legs — these were broad and provided with large webs. Its length may have been some 20 yards. In shape it was more like a crocodile than anything else."

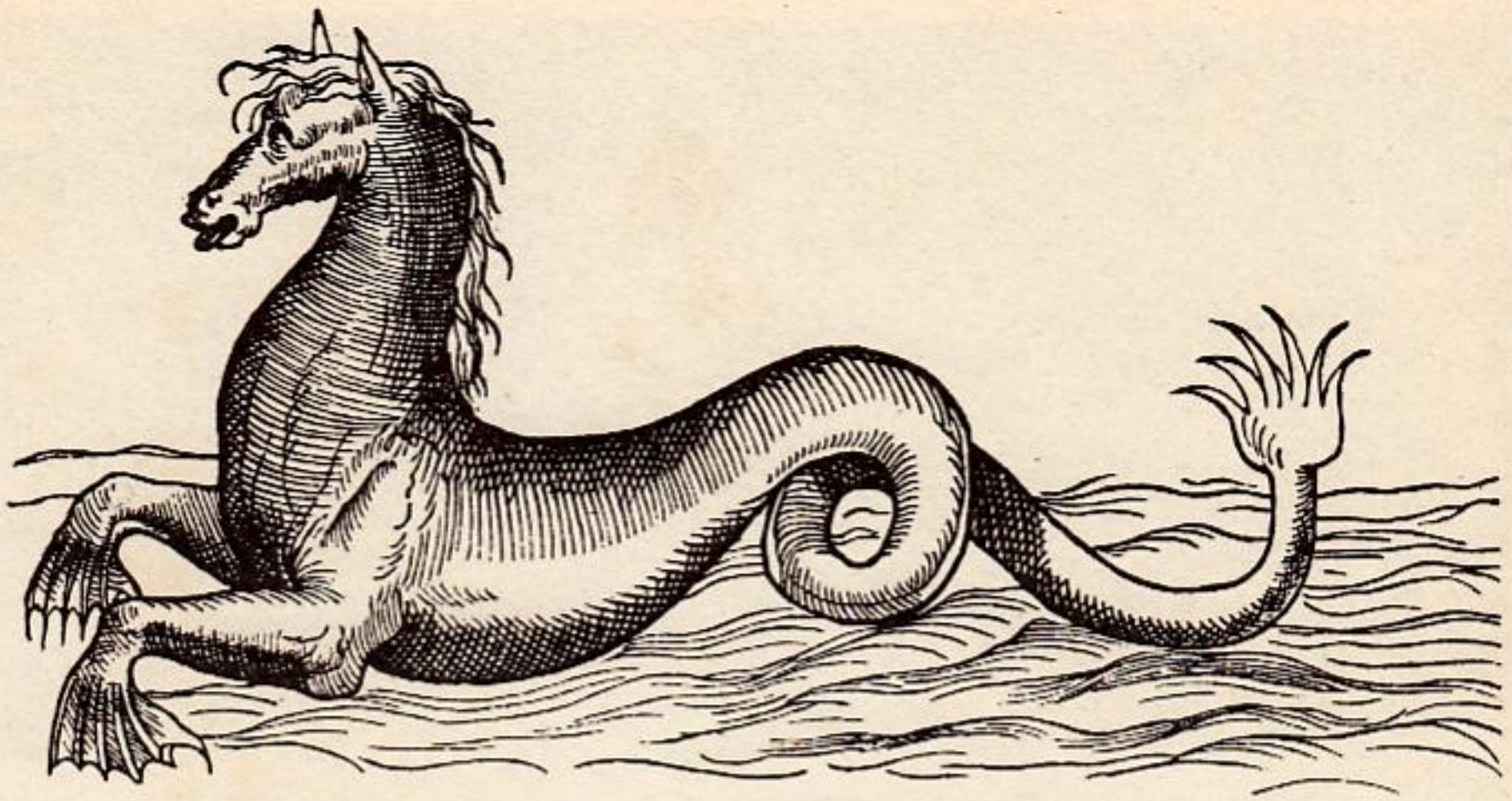
Captain F. W. Dean, commander of the cruiser "Hilary" (Great Britain), *sitting on the left.* I also took part in World War One and my cruiser was also sunk by a German submarine. But three days before, we not only saw a sea serpent or something of the kind, we even shot at it from our guns. I had a good look at the monster. Its head was like a cow's, only without horns or ears and much bigger, black all over, with the exception of a white stripe on the forehead. The length of the neck was no less than 20 feet, and the fins rose above the water some 4 feet. The total length of the creature was about 60 feet... The back fin reminded me of a black triangle, and when the animal lagged behind, we saw it *en face.* Obviously the fin was very thin and limp. True, from time to time the beast lifted the flaccid upper part of the fin... As you see, neither our monster nor Captain Forstner's bore the least resemblance to a seal.

Chairman. I must inform the gathering that after Captain Dean's meeting with the monster, nearly a dozen such meetings were placed on record between 1919 and 1933.

Voices from the right. But are you quite sure, Mr. Chairman, that those were monsters and not a conglomeration of seaweeds, as has happened



Legends about sea monsters were also fostered by swindlers, who sewed together parts of different animals to make dragons or basiliscs.



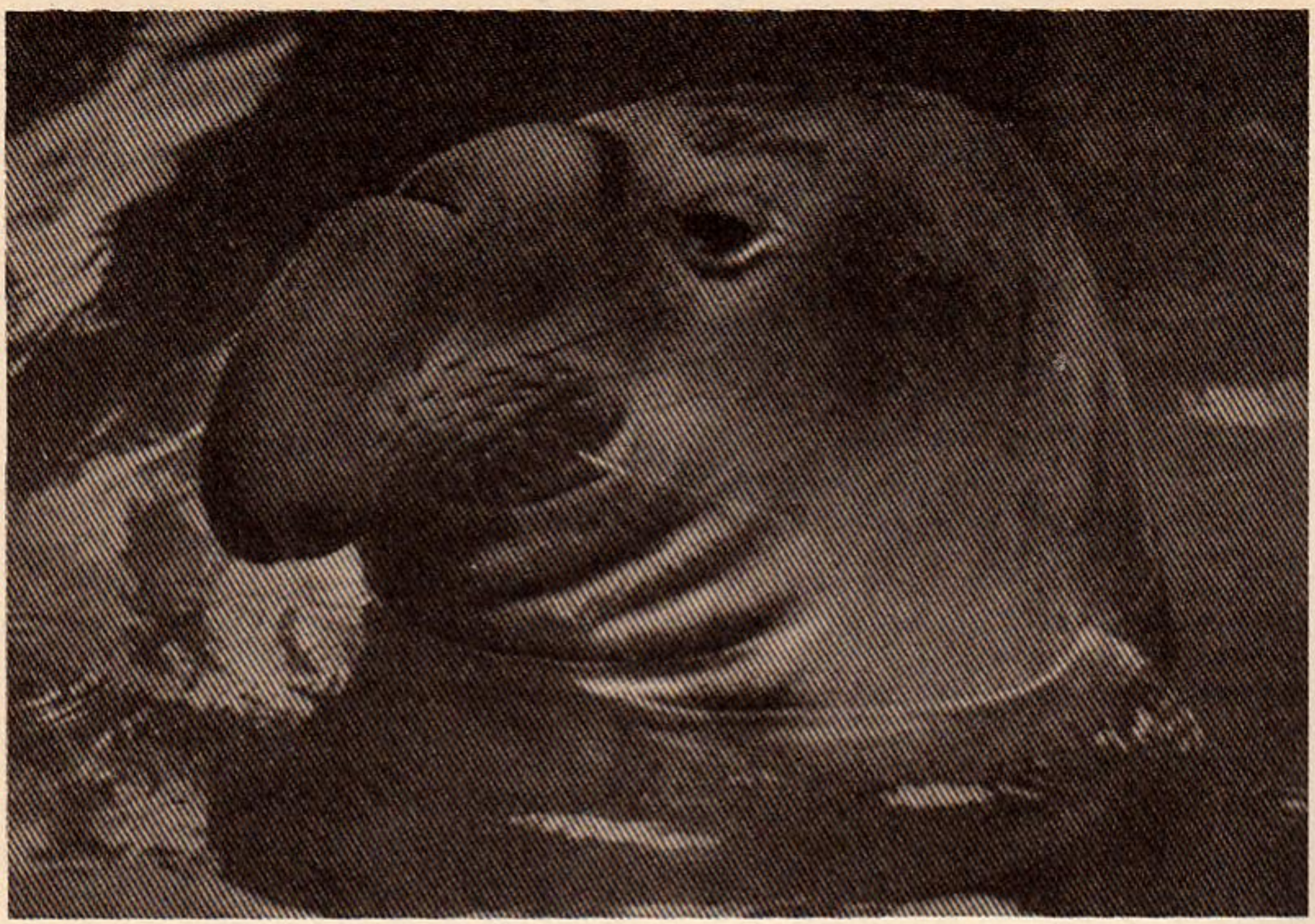
The sea urchin is a well-known fish. But could he perhaps prompt human imagination to produce this kind of sea horse?

before, or the casing of a dirigible which had fallen into the sea during World War One, or the feelers of a giant squid?

Chairman. I am not sure of any of these things, nor are the witnesses on the left or the sceptics on the right. All I can do is inform you of the records. I can also add that the start of World War Two interrupted the further study of this phenomenon. At any rate, during the whole course of the war, no information about sea monsters was forthcoming. But after the war...

George W. Saggers, a fisherman (Australia), *sitting on the left.* That's right, after the war ended, I saw the sea monster. I was fishing near the Island of Vancouver. Suddenly I felt funny. The skin on my back began to crawl, and I had the feeling somebody was watching me. I glanced round. To the left, some 50 yards from the boat, a head on a three-feet-long neck was sticking out of the water. Two jet-black eyes were fixed on me. They protruded on the head like two bottles. Never in my life had I seen anything to compare with it. The head was some 15 inches in diameter. The animal stared at me a minute, then turned away, and I saw its back. It had something in the nature of a mane, dark brown in colour, which looked more like clusters of warts than hair.

Captain of the liner "Santa Clara" (Greece), *sitting on the left.* I can tell my own story in this connection. On December 30, 1947, our liner was 60 miles from the coast of the United States. I described the happening of that day in detail for the Associated Press: "The third navigator, John Axelson, saw snake-like head sticking out of the water some 10 yards to the star-



A sea elephant can also be taken for a fantastic creature.

board. He yelled and two other officers ran up to him. The three of them stared at the newcomer in horror. His body was like a thick log, smooth, shiny, and dark brown in colour. The huge snake cut across the liner's path. For a second all lost sight of it. When they looked aft, they saw that the washback was crimson in colour and a chunk of something brown appeared for a second in the churn. The stem or the screws of the ship must have cut the monster in two."

A voice from the right. As far as we know, information about sea serpents has been coming in almost annually ever since 1948, and sometimes several encounters were recorded in one year. But the descriptions do not always tally. Does this not prove that the monster is a figment of the imagination? Surely it cannot have a different appearance at every sighting!

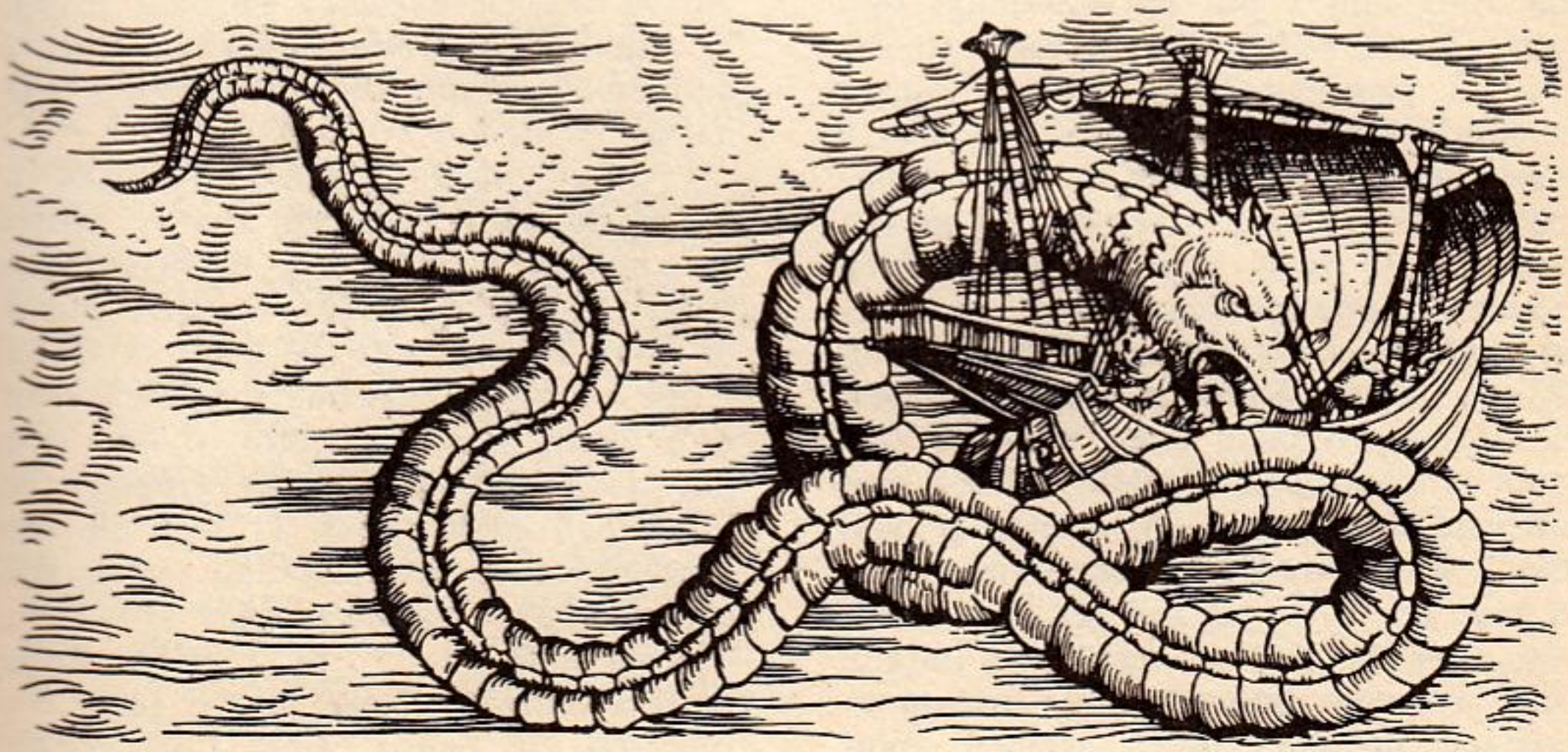
Professor Bernard Heuvelmans (Belgium), *sitting on the left.* I see no contradiction here. I am sure that what we are up against is not just one species but a group of animals differing from one another. It is quite possible that the "sea serpent" is a

mammal. As for the mane mentioned by some, I see nothing fantastic in that either. The fur-seal has a mane like that. Besides, the respiratory organs could be taken for a mane. After all, there is the so-called hairy frog whose "hair" fulfills respiratory functions.

Nor are the big eyes described by some eyewitnesses out of character. Big eyes are characteristic of animals living at large depths.

Doctor Russ (Great Britain), *sitting on the right.* Is not my venerable colleague afraid of letting himself in, with that serpent or mammal of his, for as awkward an embarrassment as the one that befell a group of Scottish naturalists who found the putrid body of a shark on the sea shore and decided it was the mysterious sea serpent and even gave it a name "the six-footed serpent", as well as a proper Latin designation?

B. Heuvelmans. No, I am not. The seemingly haphazard and contradictory mass of material I have collected renders itself easily to systematisation and suggests interesting conclusions. I have analysed the available records (I have some 600) as regards the geographical co-ordinates of encounters with the "sea serpent", their dates and water temperatures. It appears that the "sea serpent" is the denizen of middle latitudes. There have been very few meetings with it in tropical or arctic regions. Perhaps some kinds are capable of migrating from the Northern to the Southern Hemisphere and back. It was observed most often in the Northern Hemisphere between the months of May and September, and in the Southern Hemisphere between October and March. The type of "sea serpent" which has a mane, as distinct from other



But a sea elephant cannot overturn a ship, something A. Magnus asserted a whale-serpent is quite capable of doing.

varieties, occurs in colder regions almost the year round.

A voice from the right. You sound very confident, but this confidence is based on nothing more than stories told by eyewitnesses.

Robert Le Serrec (France). Why, not merely on stories alone. I can show you a photograph of an animal unknown to science. It was taken under the following circumstances. After a storm which had lasted four days, we set out in a motorboat from a small island where we had been spending our holiday, for the mainland. It happened near the eastern coast of Australia. Well, on December 12, 1964, at 9 o'clock in the morning my wife pointed out to me an object that was lying on the sea bottom at a depth of 2 to 2.5 metres. I looked hard and realised it was a huge animal the likes of which I had never seen before. The water there was very clear, and I snapped several shots of the animal lying prone on the bottom. Then my friend Henk de Jong and I put on aqualungs and went down. When the distance to the animal was not more than 7 yards, it slowly turned towards us. We beat a hasty retreat, but before fleeing, I snapped another photo. After driving us off, the animal swam slowly towards deep water and disappeared behind some coral reefs. I got a very good look at it. It was about 80 feet in length and had a massive rounded head about 8 feet both in length and in width. Its skin was uneven but devoid of scales. It was black with brown rings occurring every 5 feet or so. I did not see any teeth, although the animal opened its mouth, and I even noticed that the inner surface of the mouth seemed spotlessly white. I saw no legs or fins or any other external organs. On its head there were small, pale-green eyes. Its body tapered off and ended in a whip-like tail. The thickest part of the body was some 2,5 feet in diameter. On the animal's back gaped a wound about 5 feet in length, which bared whitish flesh. All I have told you can be confirmed by my wife and my friend Henk, as well as by the photographs I am submitting.

Ivan T. Sanderson, Professor of Cambridge University (Great Britain) *sitting on the right.* It is my opinion that the photograph shows a giant fish as yet unknown to science, most likely a giant eel. As for its size, we know that some fish, like sharks, reach a length of up to 60 feet.

Doctor F. H. Talbot (Australia), *sitting on the left.* The animal which was photographed by Le Serrec is extraordinary and unlike any denizen of the sea known to science.

Professor Anton Bruun (Denmark), *sitting on the left.* I have never seen a giant "sea serpent", but I am convinced that it exists. I am not prone to making unsubstantiated statements and shall tell you about something that happened to me.

As a young assistant zoologist I sailed aboard a research trawler which was making a trip to the south-western coast of Africa. Between the Island of Saint Hélène and the Cape of Good Hope we began trawling for fish larvae at a depth of about 1,000 ft. And one day we found an amazing creature in our small-mesh trawl. It had all the characteristics we associate with the ordinary larva of the sea eel. However, our larva was not 2 or 4 inches long, as is usually the case, but 6 feet! We pictured this "baby" once fully grown and shuddered. Judging by the usual proportions between the eel larva at

different stages of development and the adult fish, the baby we caught was to reach 70-75 feet in length by the time it was done growing. Such a fish could well be taken for a "sea serpent" or some other monster.

Doctor A. C. Oudemans (Netherlands), *sitting on the left.* I favour the opinion that the sea monsters are a species of long-necked seal unknown to science.

B. Heuvelmans. They may very well be seals, whales, eels, tortoises, fossil crocodiles...

A voice from the right. What else do you have in the way of material evidence in addition to a word of mouth, a larva of giant eel and a photograph of one "monster"?

Erik Frank Russel (Great Britain), *sitting on the left.* May I take the liberty of reminding this gathering that back in 1880, on June 10, *The New York Times* reported the finding of a huge carcass floating belly up. Sailors approached it in boats and danced on its belly. On December 1, 1896, part of an even greater carcass was washed on the coast of Florida. The newspapers carried photographs of this "chunk" which weighed about 7 tons, was twenty-odd feet in length and 7 feet wide. On June 16, 1928 *The New York Herald Tribune* reported another find on the coast of Gulf of Fonseca in El Salvador. The length of the carcass was nearly 90 feet, and its skin was striped white and black.

B. Heuvelmans. I'd like to add that in 1947, soon after the fisherman George Saggers met the "sea serpent" near the Island of Vancouver, the skeleton of a strange monster was discovered on the western shore of this island. Its head was the size of a ram's, the spine was 40 feet long and consisted of 145 cylindrical vertebrae, the largest of which was 6 inches in diameter and the smallest, 1,5 inches. The skull was some 14 inches in length, and there were no teeth.

Chairman. Does anybody else want to speak?

At once several people rose on both sides. Some wanted to tell about the strange meetings they had had, about their observations and conjectures, while others were out to prove that it was all pure invention, or at any rate, that there were no sufficiently conclusive arguments in favour of the "sea serpent's" existence.

So the controversy is still going on. And it will continue until science receives irrefutable proof of the existence of such giant denizens of ocean depths or until their absence is proved no less conclusively.

TO SUM UP THE PREVIOUS CHAPTER AND INTRODUCE THE NEXT ONE

You realise, of course, that the auditorium, the session, the commission and the chairman which appeared in the previous chapter were invented by the author. But the evidence proffered was not fictitious. The names, ranks and posts of the witnesses are all authentic, as well as their stories and opinions, which at one time or another were published in various periodicals. Such stories continue to appear in print. Only time will decide this long-standing argument. Either a new amazing animal (or animals) will be discovered in oceans, seas, rivers and lakes, or it will be proved beyond all doubt that the eyewitnesses were labouring under a delusion.

But while the zoologists argue about future discoveries and delight in recent ones, dozens and hundreds of animals we know very well are disappearing from the face of the planet. Disappearing for ever, dying out or being exterminated.

In the course of this century, about 50 new animals and birds have been discovered. Within the same period, no less than a hundred species and subspecies of animals and birds have been wiped off the face of the earth.

From the lst century A. D., man has destroyed 345 species of animals. Of them 133 disappeared by mid-18th century, and 212 in the last two centuries. Of these, 36 species of mammals disappeared in the 18th and 19th centuries and at least 40 in the 20th century.

As regards birds, only 10 species and subspecies of birds became extinct before the 18th century, 20 in the 18th century, about the same number in the first half of the 19th century, and about a hundred species of birds have been exterminated since.

These are animals and birds we shall never see again. Besides, there are many species of animals now living on Earth we can still see with our own eyes, but which will only be seen by coming generations in books or films.

Zoologists explain the decrease in the number of animals overall and the disappearance of many species in particular by a number of reasons, such as the shrinking of forests and plains, man's encroachment on wild untouched areas,

and water and air pollution.

To be sure, there are fewer forests now and the plains have largely been put under the plough. As he goes about his economic activities, man exerts an ever greater pressure on nature. Nonetheless, there are still enough forests and plains on the globe where wild animals can live and multiply. But there are very few animals left in these forests as well.

Some zoologists would put the blame for the extermination of many species of animals on primitive man. Not so long ago, *Scientific American* published an article alleging that it was the indigenous population of America that exterminated many species of animals as far back as several thousand years ago. Among them was named one species of American bison. American researchers found arrow-heads and other hunting weapons of primitive people in the skeletons of these animals. Of course, primitive people hunted animals. But they killed them only for food or in self-defence, or to take possession of a cave that provided protection from predators.

Primitive man was a friend of the animals. It is civilised man who has behaved barbarously towards them. The killing of animals on a mass scale served as a means of enrichment for some and a pastime for others.

People armed with modern weapons pose for photographs next to a heap of dead animals they have killed. They are proud of these photographs, often giving copies to their friends and sending them to magazines. And it never occurs to them that the primitive man armed with a stone axe or a crude spear is the noblest of humans beside these so-called "civilised" people.

While some scientists try to shift the blame to our distant ancestors, others argue that the development of civilisation inevitably leads to destruction of the animal kingdom and nothing can possibly save it. Some of them, like American sociologist Eric Hoffer go so far as to claim that nature is man's enemy, and the sooner he puts an end to it the better.

"Theoretician" Eric Hoffer has many supporters among practical individuals. Thus an inspector in charge of combating diseases of men and animals in South Rhodesia decided that the surest way of battling the deadly tsetse fly was to destroy all wild animals. So he went ahead with his plan, distributing weapons to the local population and encouraging them to kill all wild creatures. In the course of one year, according to his proud reports, he caused the killing of 3,219 baboons, 55 elephants, more than 27,000 various antelopes, 313 zebras, 940 forest boars, 4,503 wart hogs, 377 Kafa bullocks, 19 leopards, and so on. In the course of a single year, this man caused the destruction of 36,552 animals. And his total record is 550,594 animals.

It is hard to imagine a man bent on such an absurd, hellish task. Even if he did succeed in killing off all the wild animals in his district, the tsetse fly would have come from the neighbouring ones and, in the absence of animals, would be all the more dangerous to people. Moreover, most of the animals destroyed on

his orders are not susceptible to the disease carried by the tsetse fly.

As a result of this and similar activities, Africa now has a mere 10 per cent of the animal population it had when the first Europeans arrived on the continent. And such mad "theorists" and actual enemies of nature in the wild are still running free on our planet. Shots are heard everywhere, and the fauna of our planet is being further devastated with each passing day.

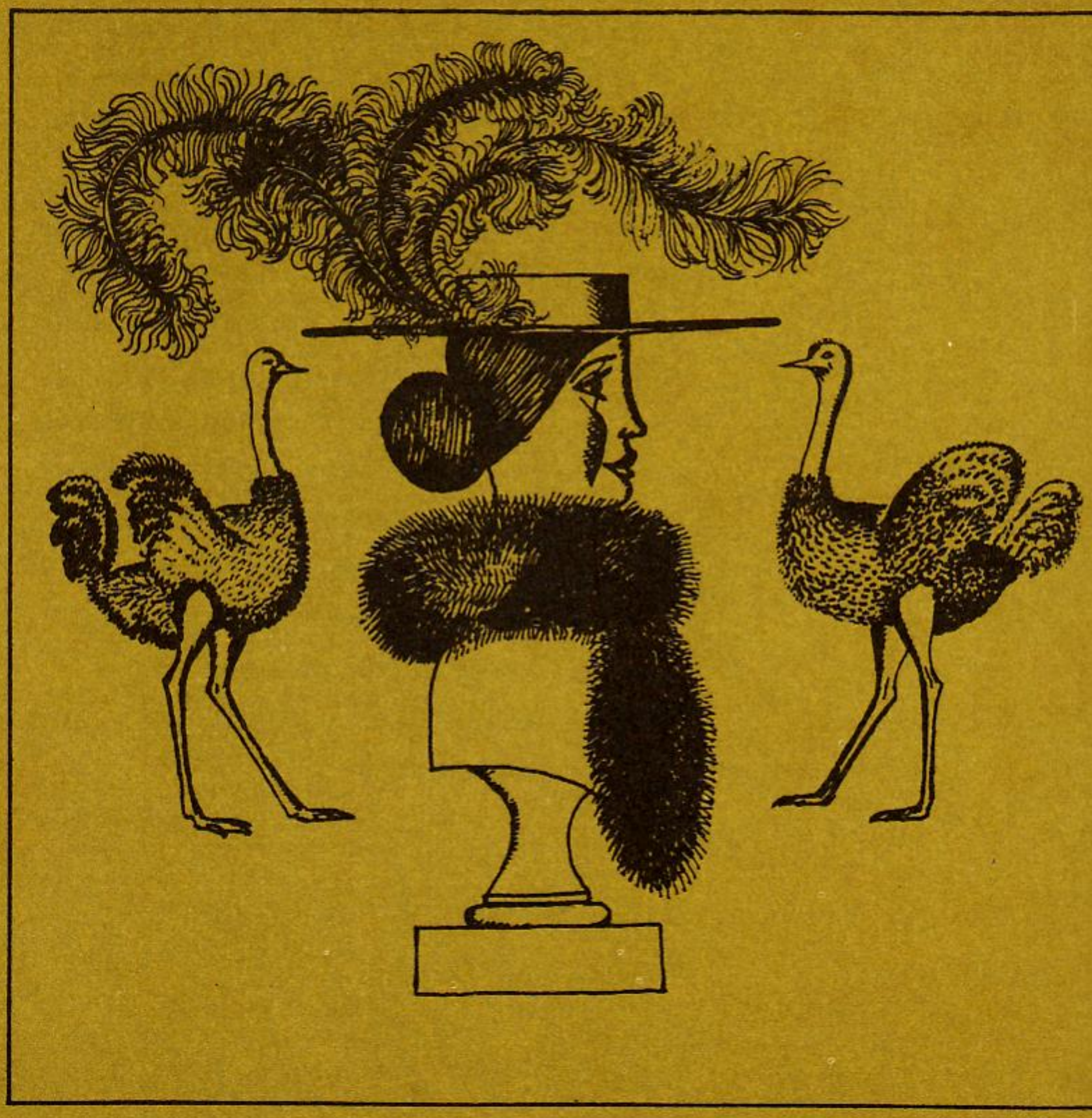
The following chapter gives some examples of this.

WE HAVE INHERITED AN INCREDIBLY BEAUTIFUL AND COMPLEX GARDEN, BUT THE TROUBLE IS THAT WE HAVE BEEN APPALLINGLY BAD GARDENERS. WE HAVE NOT BOTHERED TO ACQUAINT OURSELVES WITH THE SIMPLEST PRINCIPLES OF GARDENING. BY NEGLECTING OUR GARDEN, WE ARE STORING UP FOR OURSELVES, IN THE NOT VERY DISTANT FUTURE, A WORLD CATASTROPHE AS BAD AS ANY ATOMIC WAR... WE NOW STAND SO ALOOF FROM NATURE THAT WE THINK WE ARE GOD. THIS HAD ALWAYS BEEN A DANGEROUS SUPPOSITION.

Gerald Durrell

5

Man Kills and Destroys



The Kansas Tragedy

This tragedy took place a fairly long time ago. But people have not forgotten about it, and what occurred in the prairies of North America will make them wince with shame for many years to come.

In the prairies lived handsome and strong animals properly called bisons and known to the Americans as buffaloes. The first white man to see them was a British sailor who went up the Potomack River in his boat in the year 1612. He was amazed to see vast herds of bisons grazing there. Later travellers wrote that a herd, with animals rubbing shoulders, so to speak, could take up a territory 40 kilometres in breadth and 80 in length. They stressed the amiable character of these animals; though huge and powerful (the grown bison weighs up to 1,200 kilograms) they made way for weaker animals, and a man who found himself in the thick of a herd had every chance of getting out alive and whole.

Later it was assessed that several million bisons used to live in North American plains.

Then the settlement of these lands began. Anyone who could ride and handle a gun went buffalo hunting.

By the year 1801, not a single bison remained in the prairies. Another 32 years later, you could not find a bison in the entire eastern part of the country, from New York to the Mississippi.

But bisons still lived in the West. Approximate calculations put their number at about 60 million. So the army of hunters descended on them there.

Nor were bisons merely hunted — they were exterminated for political reasons.

Bisons wandered about the prairies, and nomadic Indian tribes followed on their trail. For the Indians, bisons were the main source of life. The Indians ate their meat, made clothes and footwear out of their hides, used these same hides for their tents and bedding and stretched them on wooden frames to build light-weight, easily manoeuverable boats — canoes. From their tendons, the Indians made bow-strings and lassoes; their bones were used to make various instruments, beginning with needles and ending with hammers, and their horns were turned into utensils and knife handles.

So naturally, the Indians hunted bisons. But they killed only as many animals as they needed for the tribe to survive. On the other hand, they saved bison calves from coyotes.

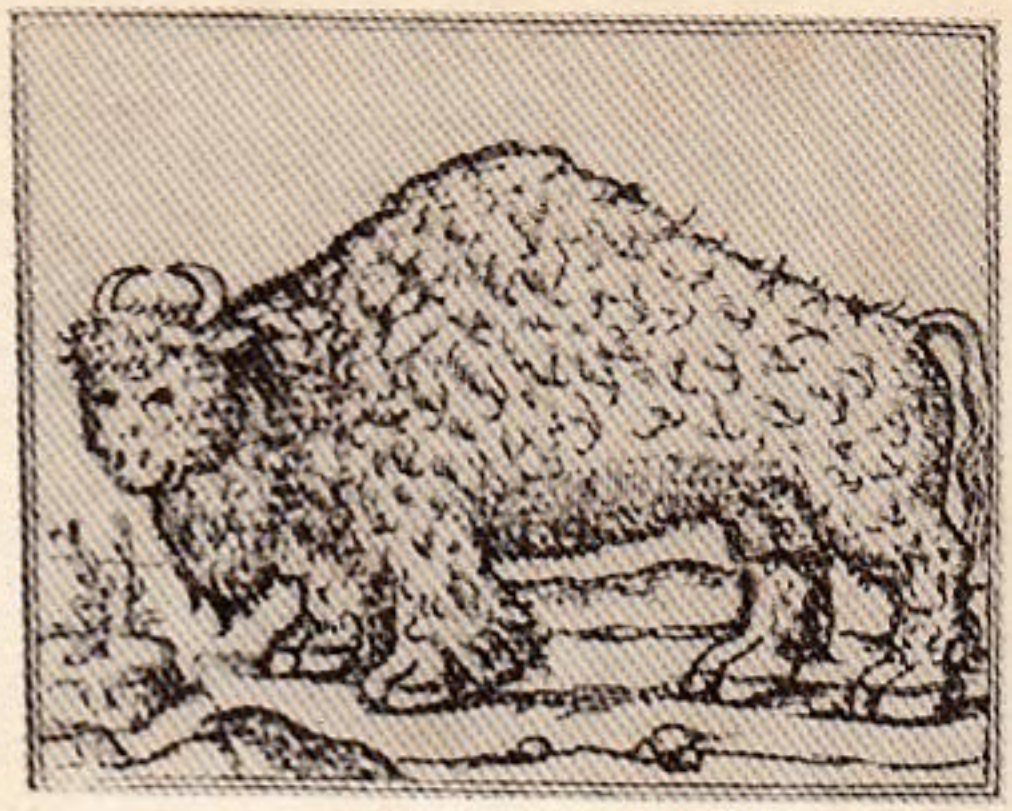
At the time America was discovered by Columbus, it is estimated, as many as a hundred thousand people lived in "bison territories", hunting them extensively. But this did not cause their numbers to shrink.

Bisons fed and clothed the Indians and thus helped these proud and free people to remain independent of the white-skinned newcomers, much to the latter's chagrin. And so, finding they could not conquer the Indians, the white men started a crusade against the bisons. Special posses of soldiers and volunteers, supplied with the ammunition by the military, began a planned assault on the herds. They followed the bison trails, leaving countless bison corpses all along their length. They were unable to use even a small portion of their trophies, nor did they want to. Their task was to condemn the Indians to starvation, and in this they were successful. The proud Sioux and other tribes, deprived of their means of livelihood, began to die of hunger and cold.

While in the North, the soldiers and hunters exterminated bisons to bring the Indians to their knees, further South, bisons were destroyed for a different purpose.

On July 1, 1862, President of the United States signed a bill setting up the Union Pacific and Central Pacific railroad companies. The building of a railroad from Chicago to San Francisco was started forthwith. The contractors soon realised that the railway builders could be provided with wholesome bison meat very cheaply. So they hired special hunters to do the foraging. But if they had killed only as many animals as were needed for food, the tragedy might not have occurred. After all, the workers did not need that much meat, and after the construction was completed, plenty of bisons would have been left. But killing went to the hunters' heads, especially since it did not entail any danger to themselves. The meek and shy animals, for all their great strength, never attempted to retaliate or attack their tormentors. Under a hail of bullets, they merely tried to get away as quickly as possible, but their great numbers prevented them from making their escape, and often as not, they simply dashed about in terror in one and the same place.

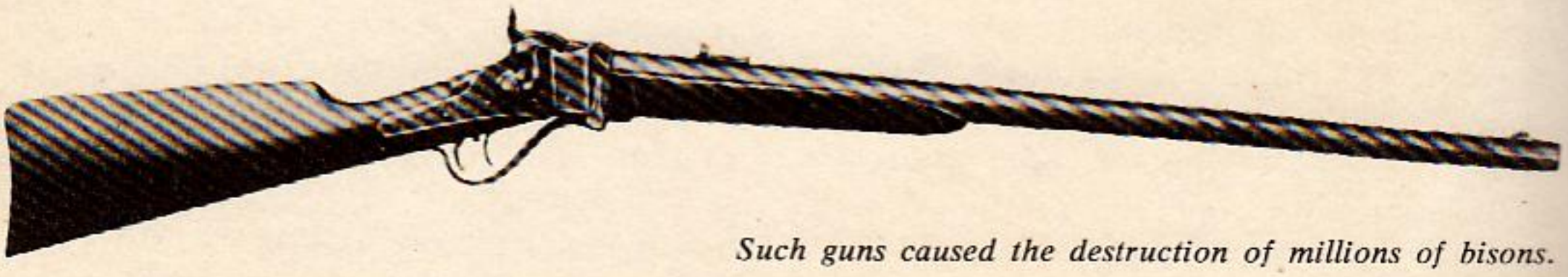
It often happened that of several thousand bisons killed, only a few chunks of meat were taken for food. Sometimes the killers contented themselves with cutting out their tongues.



One of the first pictures of a bison. An engraving of 1558.

The plains of North America, from Lake Erie to Texas, were spotted with heaps of white bones. The newly opened Pacific Railway advertised amazing hunting facilities — you could kill buffaloes without leaving the railway carriage, right out of the window!

The advertisements did not lie. The trustful animals did continue to graze close to the railway tracks. Approaching a peacefully grazing herd, the engine-driver would slow down, and fire would be opened from the windows, braking platforms and roofs. Then the train would go on its way, leaving behind hundreds of dead animals. Nobody needed their meat or their hides, all the passengers wanted was the excitement of killing.



Such guns caused the destruction of millions of bisons.

Before long the value of bison skins was realised — no wonder the Indians set such great store by them — and a new wave of bison killing started. In one hunting season (two or three months) more than 200 thousand bisons were killed in the state of Kansas alone. Altogether, between 1870 and 1875, some 2.5 million animals were killed annually.

Goods trains packed with bison hides were rolling along the new railway. The hides were bought up by a special company. Another company was formed to utilise the bones for fertiliser and black dye. In a matter of two years "procurements" of bison bones reached 8.5 million kilograms.

After several years of this indiscriminate slaughter, bisons disappeared from the North American plains. The few remaining herds took refuge in Texas, but the hunters caught up with them there. In 1883 they killed the last 59 bisons in Texas. Only 4 animals remained alive, but these, too, were found and killed in 1889.

In 1880, the last bisons in the North also met their doom. The hunters tracked down a large herd which had somehow escaped the slaughter, and in the course of three months, killed every single animal, each hunter averaging from one to two thousand bisons.

Within 50 years the Americans had destroyed a population of 75 million bisons!

The history of the European bison is different but no less tragic.

Centuries ago, some of the wild oxen living on the territory of Europe and Asia moved to America via the isthmus that existed in those years between Asia and North America. Gradually, they became what we know as the American bison. The oxen who remained "at home" developed into the European bison.

The second part of the 19th century spelled tragedy for both branches of the bison family.

But the destruction of the European bison began much earlier.

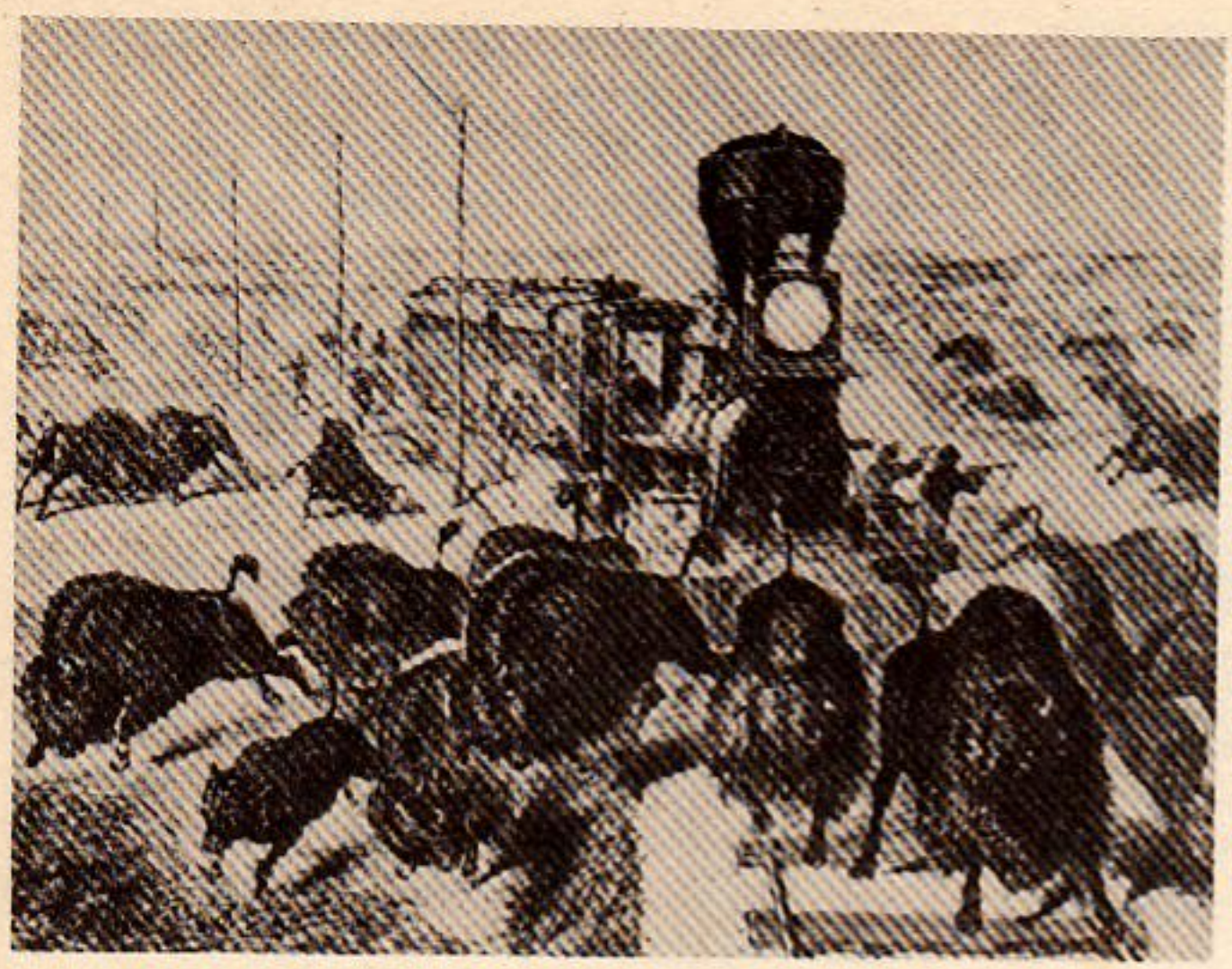
Herds of these animals were widespread in Europe in the Middle Ages. Only on the British Isles and on the Pyrenean Peninsula were they destroyed in ancient times.

Chronicles tell us how many bisons were killed on one occasion or another. We know, for instance, that a congress of princes held in Volhynia in 1431 consumed at their feasts 100 roast bisons every week.

In the 15th century, there were many bisons on the territory of Muscovy too. The famous German traveller Herberstein who visited the Moscow state in the 16th century and even drew up a map of Muscovy presented the bison as the symbolic animal of this land.

But a mere 150 years later there were practically no bisons left in Europe. No one staged any mass exterminations as they did in America, but both the meat and the hides of bisons were in great demand. And so the bisons were destroyed in France; Romania's last bison was killed in 1762, the last bison in the Baltic region in 1755, and in Germany in 1793.

Toward the end of the 17th century the numerous bison herds disappeared in the Ukraine. The last bison coming from these parts is mentioned in Mazepa's letter of 1696: in it Mazepa, the Ukrainian Hetman, informed the tsar's court he was sending a bison along. In the Don country, from where bisons hides had been brought in fairly large numbers, these animals also became practically nonexistent towards



The railway advertisements were true enough — one really could hunt bisons safely from the window of the train.

the end of the 17th century. And when, in 1716, Peter the Great ordered the Governor-General of Voronezh to catch several bisons and send them to St. Petersburg, the latter replied that bisons had last been seen on the Don in 1709 and "after that day, no one has set eyes on them".

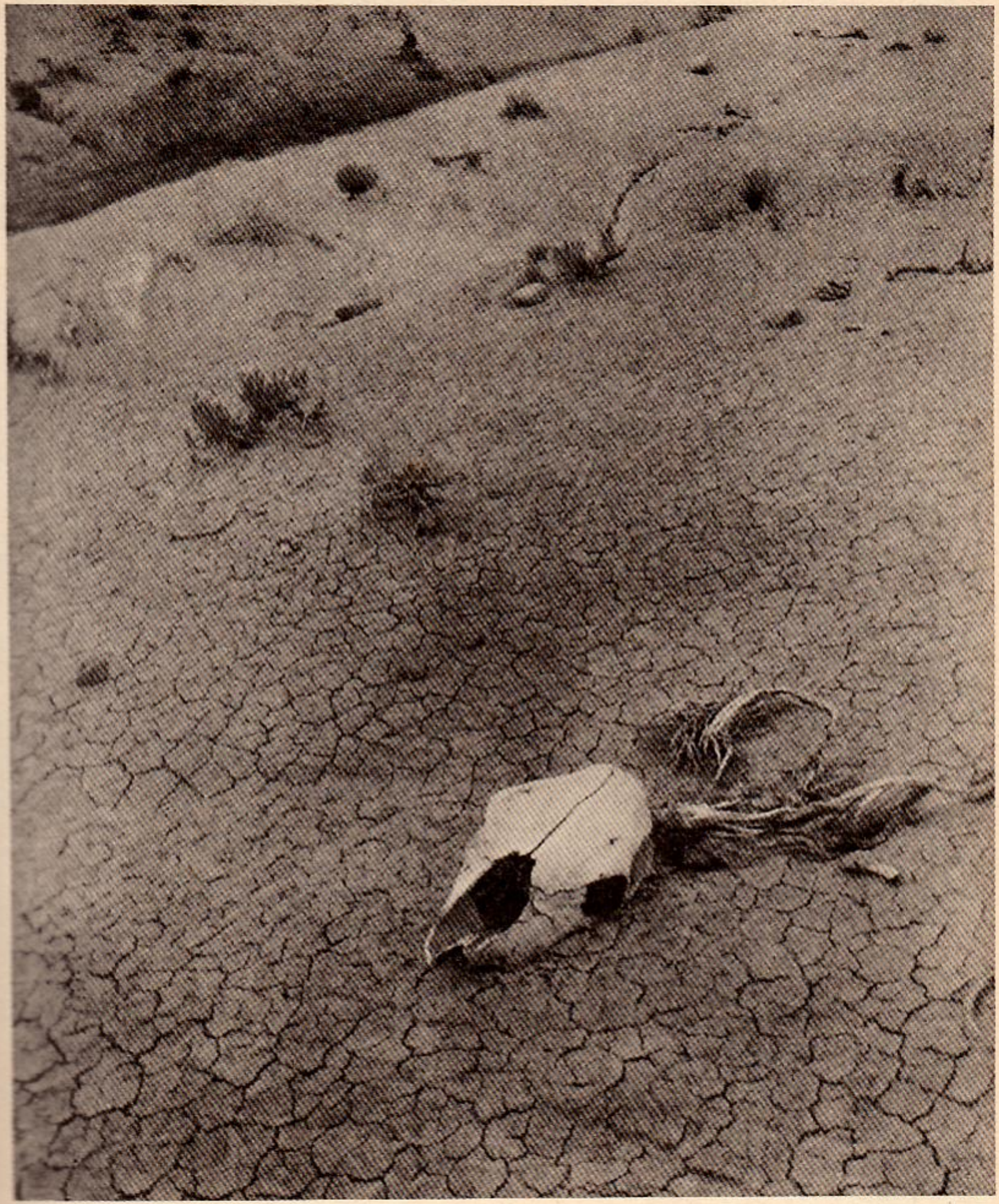
Bisons left the open grazing lands in the steppes and went into the forests where hunters could not find them. But people caught up with them everywhere, and only a small group of animals managed to survive in the boggy woodlands of Byelorussia, Byelovezhskaya Pushcha. The natural conditions were not propitious, but the bisons survived, because in the end, people came to their senses and hunting these animals was prohibited. By 1914, 727 bisons were living in Byelovezhskaya Pushcha.

But people did not behave sanely for long. In August 1914, the First World War began, and Byelovezhskaya Pushcha was overrun by the German army. German zoologists, who appreciated the value of these animals, did everything in their power to save them. With great difficulty they induced the German Command to issue an order protecting the bisons, but it was not very effective. The hunting begun by the Germans was continued by poachers after the German army retreated, and only one bison cow lived to see the year 1920. In February 1921, she was killed as well.

This marked the end of the last free-living group of bisons. But a few still lived in nature preserves and zoos.

As soon as Soviet power was established, zoologists began assessing the number of surviving animals. They learnt that all the 36 bisons which lived in the Gatchina Park near Petrograd had been killed by the Cossacks in early 1917.

The bisons living in the park near Minsk had been killed by unknown persons in 1918.



Vast herds used to roam here.

Neither strength nor fast legs could save them from poachers' bullets.

The bisons living in the Crimea had been destroyed by the White Army of Wrangel.

A variety of bisons lived in the Caucasus. The herd was fairly large — some 500 heads. But in 1920, only 50 were left, and even they could not be saved from poachers. In 1927, the last Caucasian bison was dead.

Still, the American and European bisons were more fortunate than many other animals: people finally realised they were heading for catastrophe, and in the beginning of this century, a society for the salvation of bisons was formed in the United States, and in 1923 an International Society for the Protection of the Bison was set up in Europe.

Fortunately these societies managed to obtain results — both the American and European bisons were saved from total destruction. (Of this, you can read in more detail in the next chapter.)

The extermination of bisons — this mass, senseless, cruel slaughter — is not the only such occurrence in the history of man's relations with animals.

In 1902, the Belgian zoologist A. L. Lemerre wrote in his report to the University of Brussels that total extermination of the genus of zebra through the use of firearms was a matter of a few years.

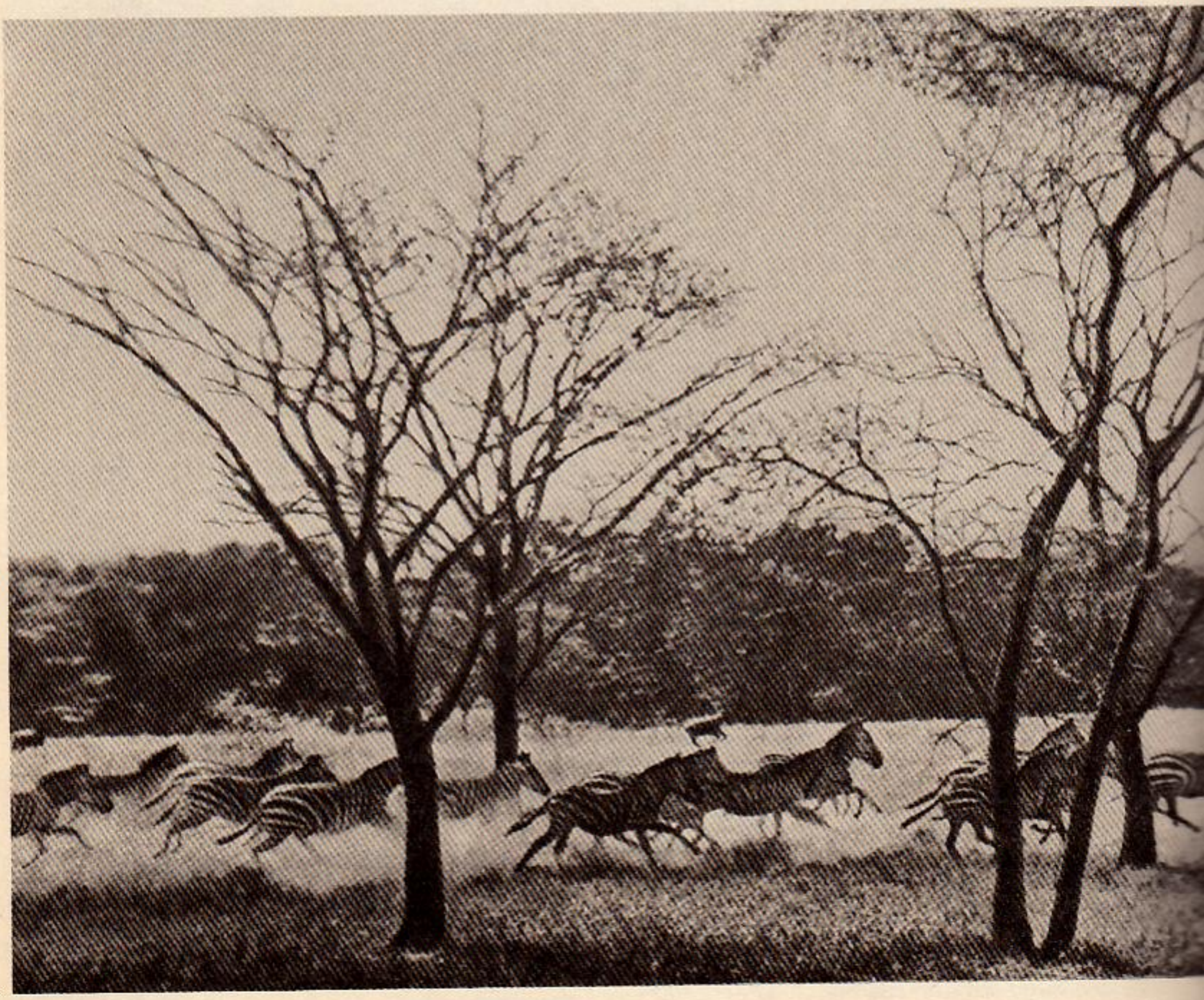
Lemerre was fully justified in his gloomy forecast. Vast herds of handsome "sunny horses", as zebras were called, used to graze in Africa's savannahs. The Africans hunted them, to be sure, but the genus of zebra was not cut short, for the Africans engaged in hunting, not mass extermination. Extermination began with the coming of white-skinned conquerors: within a few decades, the huge herds of zebras were almost all destroyed.

Zebras were not in the way of the

European bisons in a preserve.

people — there was enough space in Africa for both people and wild animals. But the colonists soon realised what an easy prey zebras were and how useful they could be. They fed their meat to their African field-hands, who were virtually their slaves, and used the skins as bags for water and grain.

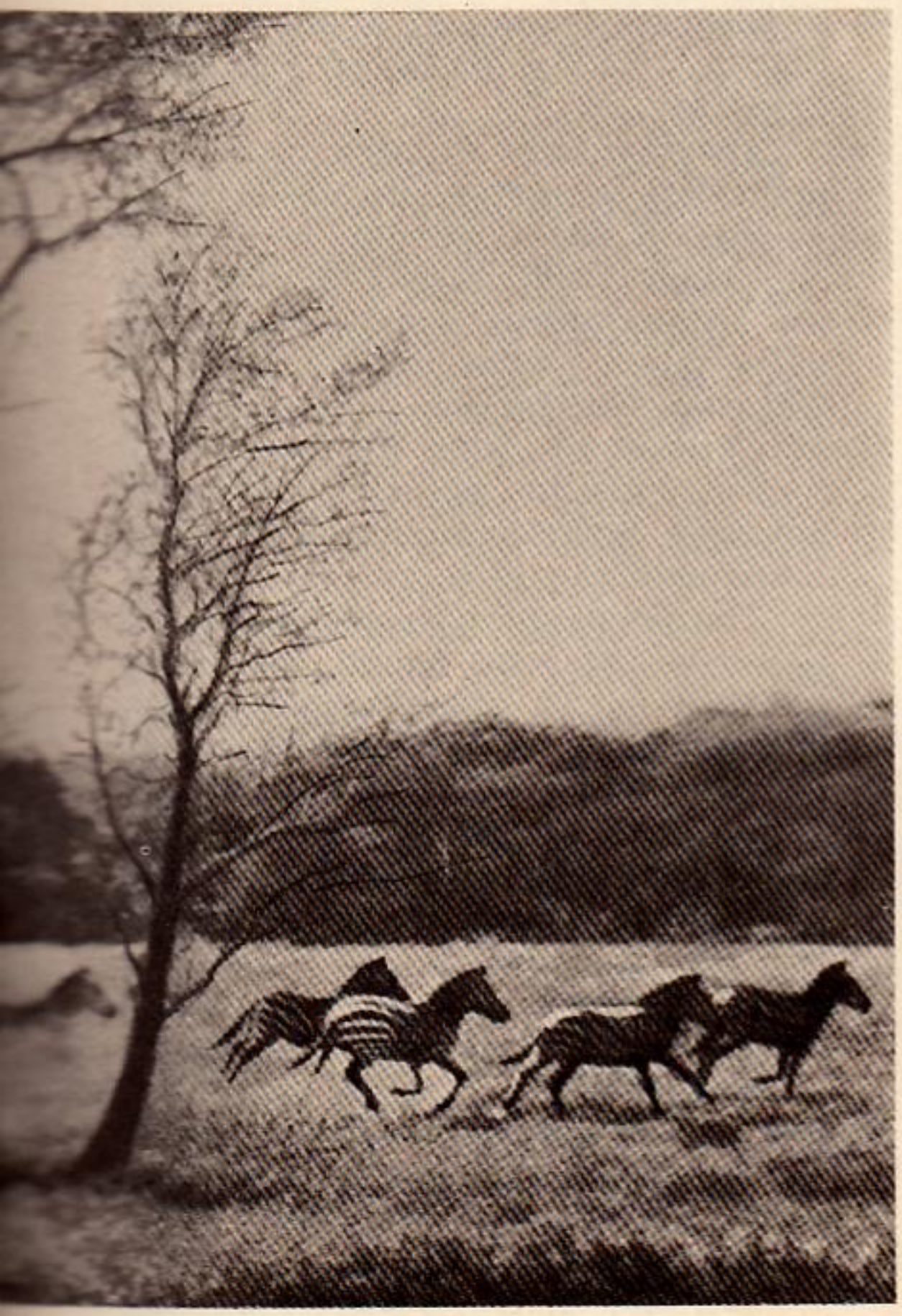
Then they resolved to get rid of zebras altogether. The slaughter that followed can only be compared with the slaughter of bisons in America. Thousands of "sunny horses" were brought down by the bullets of the colonists. And still the latter were not satisfied. Another method of destroying zebras was found — a faster, easier and cheaper one — with no powder or bullets spent. Herds of zebras were chased towards the sheer edges of cliffs and were dashed to death on the rocks below.



"Total extermination of the genus of zebra through the use of firearms is a matter of a few years," wrote a Belgian zoologist at the beginning of this century.

Meantime, European zoologists were studying zebras and making interesting discoveries.

Zebras were known in Europe during antiquity. The Romans brought them from Africa. Their name for them was hippotigris. But in subsequent centuries the Europeans forgot all about zebras, and the stories of Portuguese seafarers about striped horses living in Africa were not believed.



Later, when the existence of the zebra was impressed on the European mind, arguments began as to what was its fundamental colour — black or white. Were they white with black stripes or black with white stripes?

While studying the problem, zoologists established that zebras differed in colouring: some had broad stripes, others, narrow; some had a colour scheme of white and black, others of white and brown.

There were also structural differences.

Zoologists differentiated several species of zebras. And in 1882, when everything there was to know about the animals seemed to be known, a new species was discovered.

It was named after the French President Jules Grévy. And not because the president was naturalist or even simply loved zebras. Simply he received, as a gift from the Emperor of Ethiopia, a zebra, the likes of which had not been seen in Europe.

The president had no use for a zebra, so he donated it to a zoo. They did not know how to feed and care for it at the zoo, and the zebra soon died. But the zoologists studied the dead zebra and another name appeared in the list of our planet's denizens, Grévy's zebra.

But the discovery of new facts about the zebra did not stop here.

Structurally, most zebras resemble donkeys: a thick cylindrical body, a short massive neck, and long ears. The mane is short and bristly and the tail is broom-like.

Naturally, the three species of zebra known today are all distinct, but the fundamental features are the same.

Zoologists believed that those features were only characteristic of the males.

The females were quite different: they had small ears, a thick bushy tail, and their neighing resembled the horse's. Another distinction was that the females had stripes only on the head, neck and shoulders, the rest of the body being dark in colour.

Considerable time had to pass before zoologists became aware that this handsome animal was not at all the female of the known species but a species in its own right.

The quagga, as this zebra was called in Africa, interested zoologists greatly, but they never had the chance to make a thorough study of it. For the quagga, the most numerous and the most interesting of the zebra family, was exterminated with particular ferocity, because it lived in the south of Africa where Europeans began to settle earlier than elsewhere on the continent. It had barely been discovered by zoologists when it was exterminated to the last animal.

After the last free-living quagga was killed, a few quaggas remained in the zoos. But they were not to live long. On August 12, 1882 (the year Grévy's zebra was discovered and four years after the last free quaggas were killed) the last surviving quagga on Earth died in the Amsterdam Zoo.

The quaggas were exterminated. Their close relatives, Grévy's and Burchell's zebras, barely escaped a similar fate.

The same applies to many other animals.

Predators Appeal for Help

The lion is the king of beasts, a title which has never been contested. But why was it conferred on the lion? Is it the strongest of predators? Hardly. The tiger is probably stronger. Is it the most agile? No again, the leopard exceeds it in agility. Is it the biggest of predators? Again the answer is no. The grizzly bear weights 350 kilograms, the polar bear reaches 700 or 800 and even the tiger, which weighs 300, is bigger than the lion whose grown male never exceeds 230 kilograms. Nonetheless the lion is the acknowledged king of beasts. And rightly so. It earned the title not so much for its strength as for its royal bearing, and for its proud and noble character.

The lion lives in open country; it never lies in ambush or steals up on its prey. It attacks openly, warning all and sundry with its mighty roar that the king of beasts is out hunting. All living things shudder at the sound of that roar. But the lion is magnanimous too: it never kills when it is not hungry. Aware of this, its "subjects", zebras and antelopes, graze unafraid not far from a lion eating its prey.

The lion has been glorified in legends and tales for good reason, and many countries put its image on their coats-of-arms. But, sadly, the time seems not far off when the king of beasts will only remain in tales and on coats-of-arms, and on photographs and film. (Lions were more fortunate than quaggas in that they lived to see the flourishing of photographic and cinematic techniques, while a quagga was only photographed once.) It is more than likely that several generations hence, people will look at the photographs admiringly, marvelling that such handsome beasts actually lived on Earth.

Yes, they lived on Earth, and not only in Africa. They used to live in Europe and Asia. Less than a thousand

years ago, there were lions in the Caucasus, on the territory of today's Ukraine and in the lower reaches of the Don.

It was probably in the vicinity of today's Rostov-on-the-Don that Prince Vladimir Monomakh of Kiev (1053-1195) met "a ferocious beast" he described in his *Instruction.* "The ferocious beast jumped on my hips and felled the horse and myself." There exists an illustration of this episode made in the time of Vladimir Monomakh — a fresco in the Cathedral of St. Sophia in Kiev. The fresco portrays a yellow cat of huge dimensions attacking a rider who is piercing it with a spear. Scholars believe the huge cat, that very "ferocious beast", is actually a lion, which, incidentally, is also mentioned in *The Lay of Igor's Host.*

Lions lived in Europe, but disappeared long ago. Berber lions, proud and handsome beasts which lived in North Africa, were destroyed only fairly recently — the last Berberian lion was killed in Algeria in 1893.

In the south of Africa there used to live a species of lions called the Cape lion. But they no longer live there: the last Cape lion was killed in 1922.

There are still lions to be found in Central and Eastern Africa, but their numbers have dwindled. A negligible number of lions still live in India in the Chir preserve on the Kathiawar Peninsula. Some data say there are a hundred of them left, while others name the figure of 250-300. But even if there are 300, the number is far too small.

There are several reasons for the reduction in the lion population. One of them is disappearance of the formerly numerous herds of zebras and antelopes: as the available food diminished, so did the number of lions.

The decrease in the numbers of wild animals forced lions to attack domestic animals. So the second reason arose: the local population began to kill off lions. Many lions died of spear and arrow wounds. But their number is small compared to the masses which fell from bullets.

This is the third, and I dare say, the main reason for the lion's impending demise.

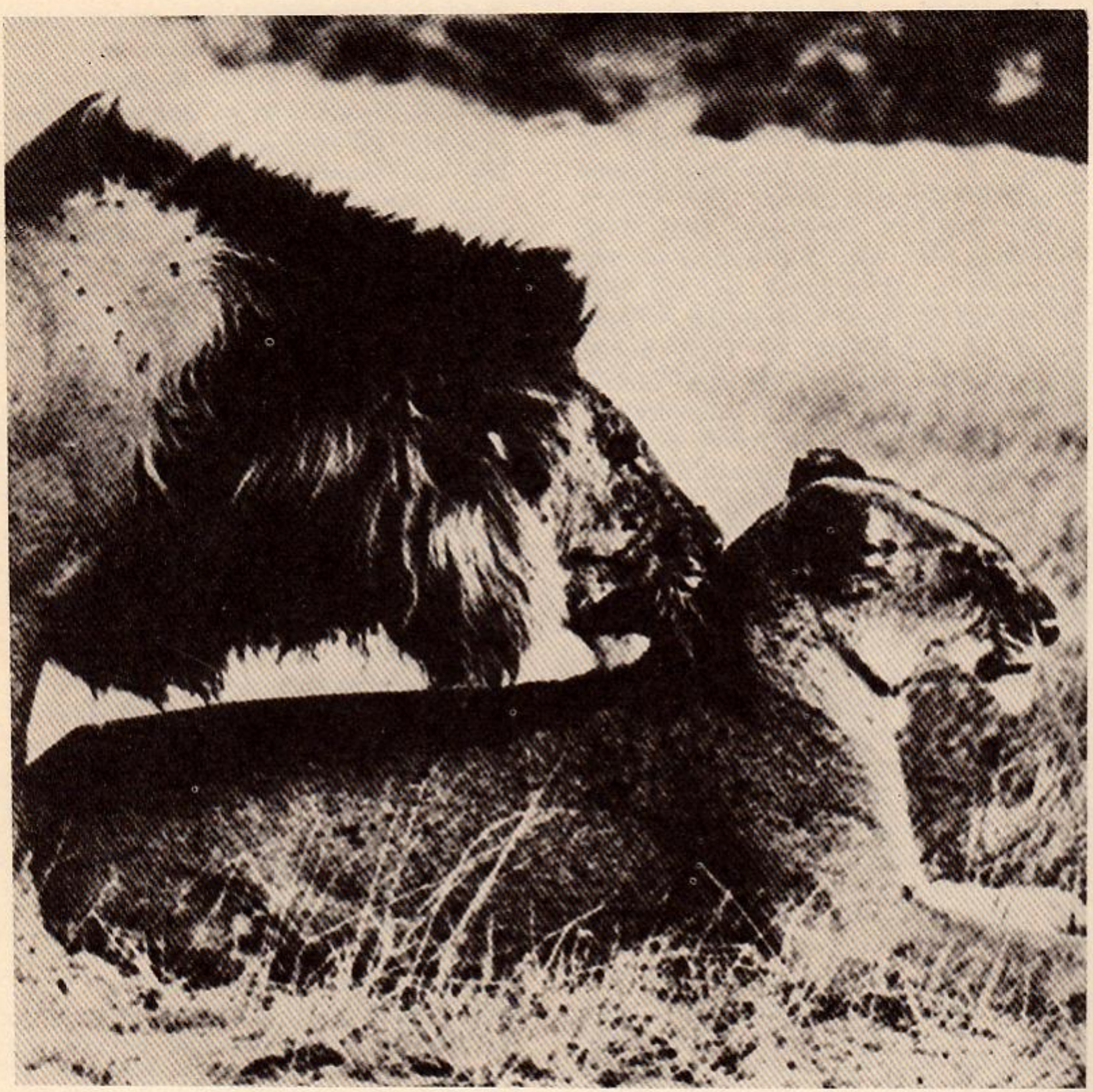
Hundreds of Europeans and Americans armed with the latest firearms, professing to be big game hunters although their pastime had nothing to do with real hunting, flocked to Africa. They had only one aim: to go on a safari, to have a thrilling time, and to bring back lion skins as trophies.

Sometimes they killed so many lions they were unable to skin them all — they just took photographs beside the felled king of beasts and cut off his tail as proof of their feat. Some such "big game hunters" killed as many as a hundred lions in one season.

Back home, they were met as heroes. Of course, their trophies never failed to impress. It was no joke to take the mighty and crafty king of beasts on single-handed. Few realised that it did not require much courage or skill to kill a lion, an animal who never tried to hide or to retreat in the face of danger.

Lion hunters were lauded as the most courageous of men and, moreover, mankind's benefactors — were not they ridding people of one of the most dangerous of predators?

In those not so distant times, all predators were regarded by the majority of people as enemies to be ruthlessly destroyed.



Predators are in need of protection as well!

In many countries, bounties were paid for killing off predators. Up till 1909, a bounty of 25 dollars was even paid for the killing of such a rare animal as the Tasmanian wolf, a marsupial living in Tasmania alone.

Zoologists today know very little about this unusual animal, for its destruction proceeded at a much faster rate than the study of it. But even the little we do know shows that the animal was a unique one. Everything about it was unusual — its great strength and its fear of man, the pouch on its belly where the newly-born cub spent the first months of its life, and its ability to make its escape by huge leaps on its hind legs in the manner of the kangaroo.

The Tasmanian wolf never attacked people, but it did steal sheep. And for that people waged war on it.

Today it is protected by the state. There is a 500-dollar fine for the killing of a Tasmanian wolf. But since 1938 when the animal was taken under state protection, the fine has never once been paid.

Moreover, the Tasmanian wolf has never even been sighted. There have been stories about meetings with animals which resembled wolves, but so far they remain unsupported by material evidence.

Zoologists believe that some animals have survived in remote mountain regions of Tasmania. But even if this is so, they have little chance of keeping the species going.

The Tasmanian wolf was sometimes called the Tasmanian tiger because it has stripes on its hind quarters. This is quite wrong for the animal has nothing in common with the tiger except perhaps that they will share the same fate, for if the destruction of tigers is not stopped,

The portrayal of lion in a Russian illuminated manuscript of the 15th century.

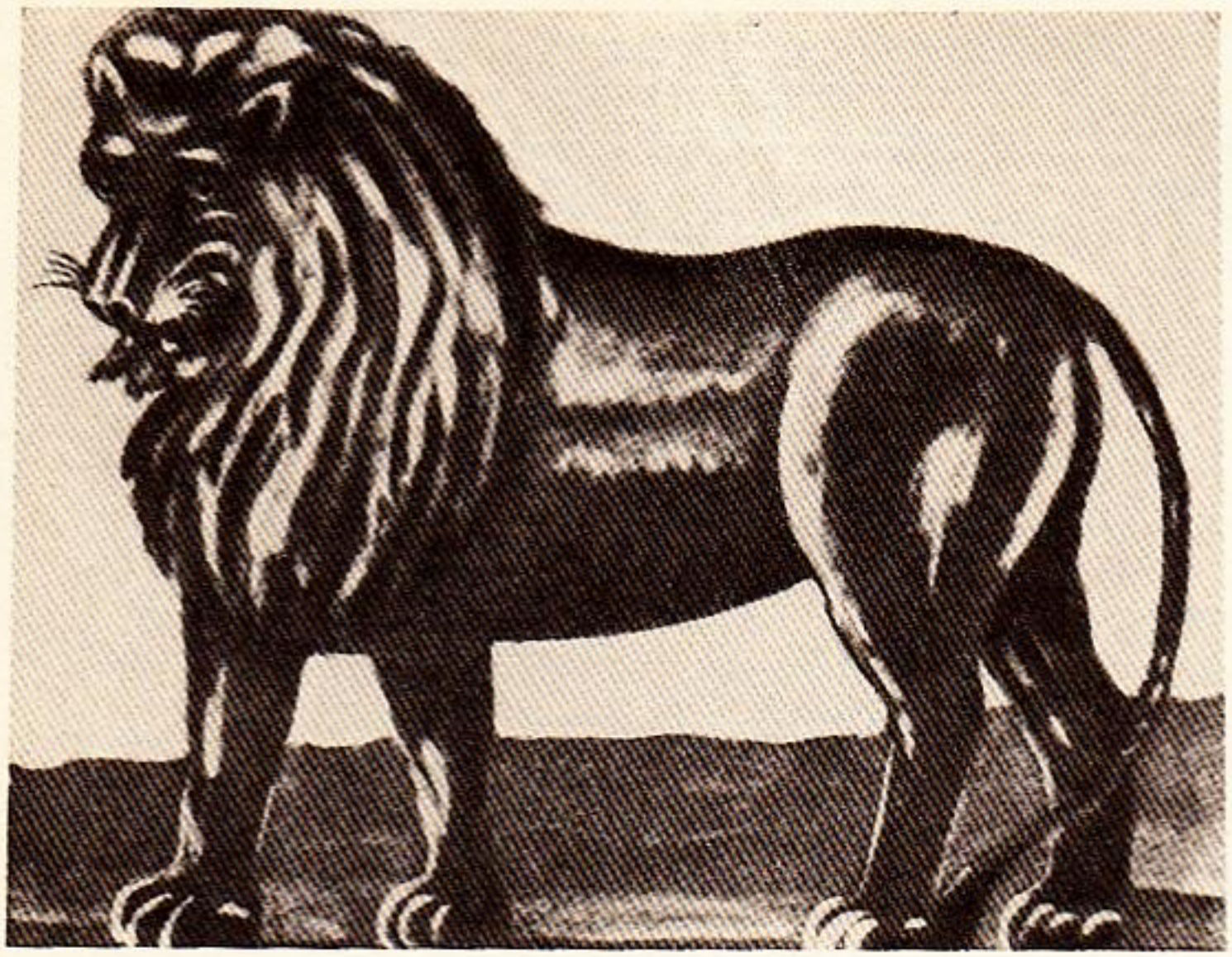
they too may soon vanish from the face of the earth.

The same applies to the biggest predator of North America, the grizzly bear. (In all the forests of North America, there are no more than a thousand grizzlies left.)

A similar fate has befallen many other predators of Europe, Asia, America and Africa. Some have been destroyed completely, while others are on the brink of extinction. Such sad cases require rapid action on the part of conservationists.

But is there any sense in saving predators? Perhaps they really ought to be destroyed?

We will discuss this problem in the next chapter.



This picture of a lion was painted by the Georgian artist Niko Pirosmanishvili (Pirosmani) in early 20th century.

Giants Need to Be Saved

About a hundred years ago, an elephant escaped from the circus in the town of Odessa. It refused to go back point-blank, so a troop of soldiers were ordered to shoot it dead.

All kinds of things were said in explanation. Some said the elephant had run amok, others that it had been driven to this act of desperation by cruelty. It was also said (and this is the most feasible explanation) that the elephant was a very meek animal, and the whole thing was instigated by the circus-owners for publicity purposes. They were not sorry to lose the elephant who was old and no longer suitable for the arena.

At any rate this incident was much written up. Most people did not believe the elephant was mad and were sorry for it. These kind-hearted people probably had no idea that an average of a hundred and fifty of similar good-natured giants were being slaughtered in Africa daily. Fifty thousand elephants killed in a year, such was the officia! figure in the second half of the 19th century. In actual fact, the number was at least twice as great.

Of course elephants had been killed before. Several millennia ago, they were used as "fighting animals", as a kind of tank. Naturally, some of them perished in battle.

Local inhabitants also hunted elephants. They rated elephant meat highly, while its tongue, heart and the tip of the trunk were considered great delicacies. They also used elephants' tusks for manufacturing rings, bracelets, goblets and bowls which they sold for almost nothing.

On the other hand, ancient Greeks and Romans valued ivory very highly. The *Iliad* tells that the Trojans adorned

the horses with ivory. The palaces of Odysseus and Menelaus were also decorated with ivory. Some statues known as chrysoelephant, were a combination of gold and ivory.

Rich Romans took pride in using costly ivory for all kinds of household articles, including table legs.

This alone makes it obvious that elephants have been hunted since ancient times. And intensively, too. Nevertheless in 1903 it was still possible to see huge herds of elephants in Africa. But numberless pits yawned in African soil, and many thousands of elephants died in agony on stakes set up in those pits. And all this so that people could play billiards with balls made of elephant tusks.

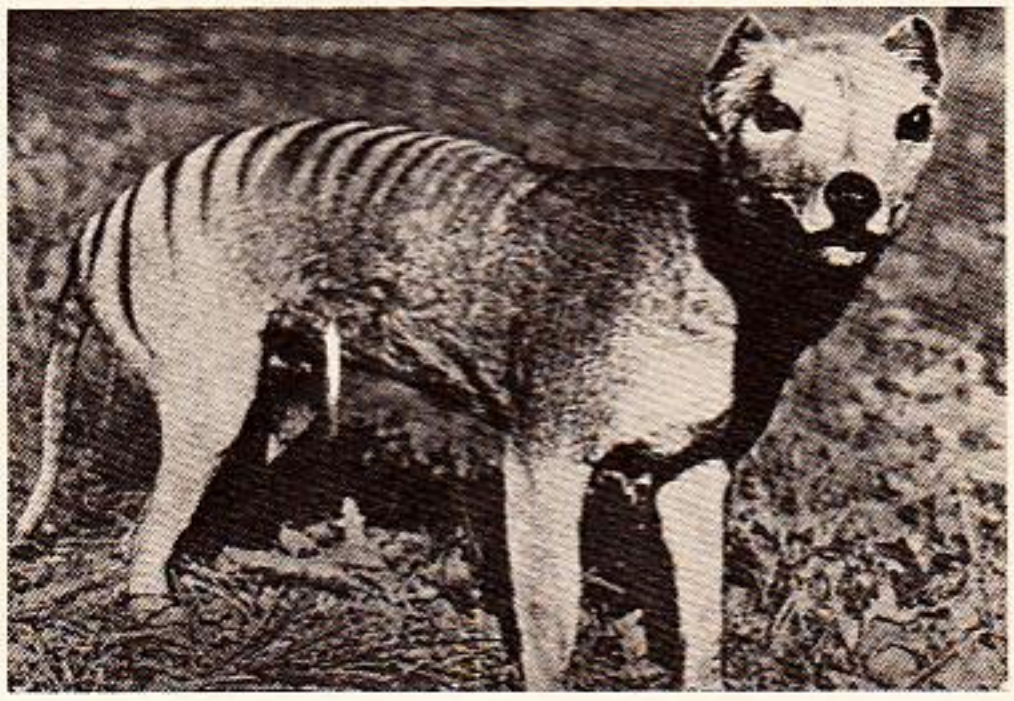
Meanwhile the need for ivory was growing steadily, and special "companies" were set up to ensure a steady supply of ivory.

All through the late 19th and early 20th centuries, 50-100 thousand elephants were killed annually. This was a really appalling figure. As a result, the huge herds of elephants shrank and disappeared since their birth rate was not sufficient to make up for such gaps.

There were no more giants with tusks weighing several dozen kilograms. To satisfy the demand for ivory, many more animals had to be killed now. And the demand never fell off. In Great Britain alone, in 1955-1960, about 3,000 kilograms of ivory were sold annually. To obtain so much ivory several hundred elephants had to be killed. And, mind you, not only the British bought ivory!

The number of elephants is dwindling fast, but still, the slaughter continues. In Kenya alone, up till recently, some 4,000 or 5,000 elephants were killed legally and illegally every year. Actually

Bears still live on earth, still roam the forests. But their numbers shrink with each year.



The marsupial wolf. Are there any such animals still in existence? The last time one was seen was 1935.

A lion hunt. An ancient Oriental miniature.

ivory is no longer the only attraction: a profitable branch in tourist trade are waste-paper baskets made of elephants' feet.

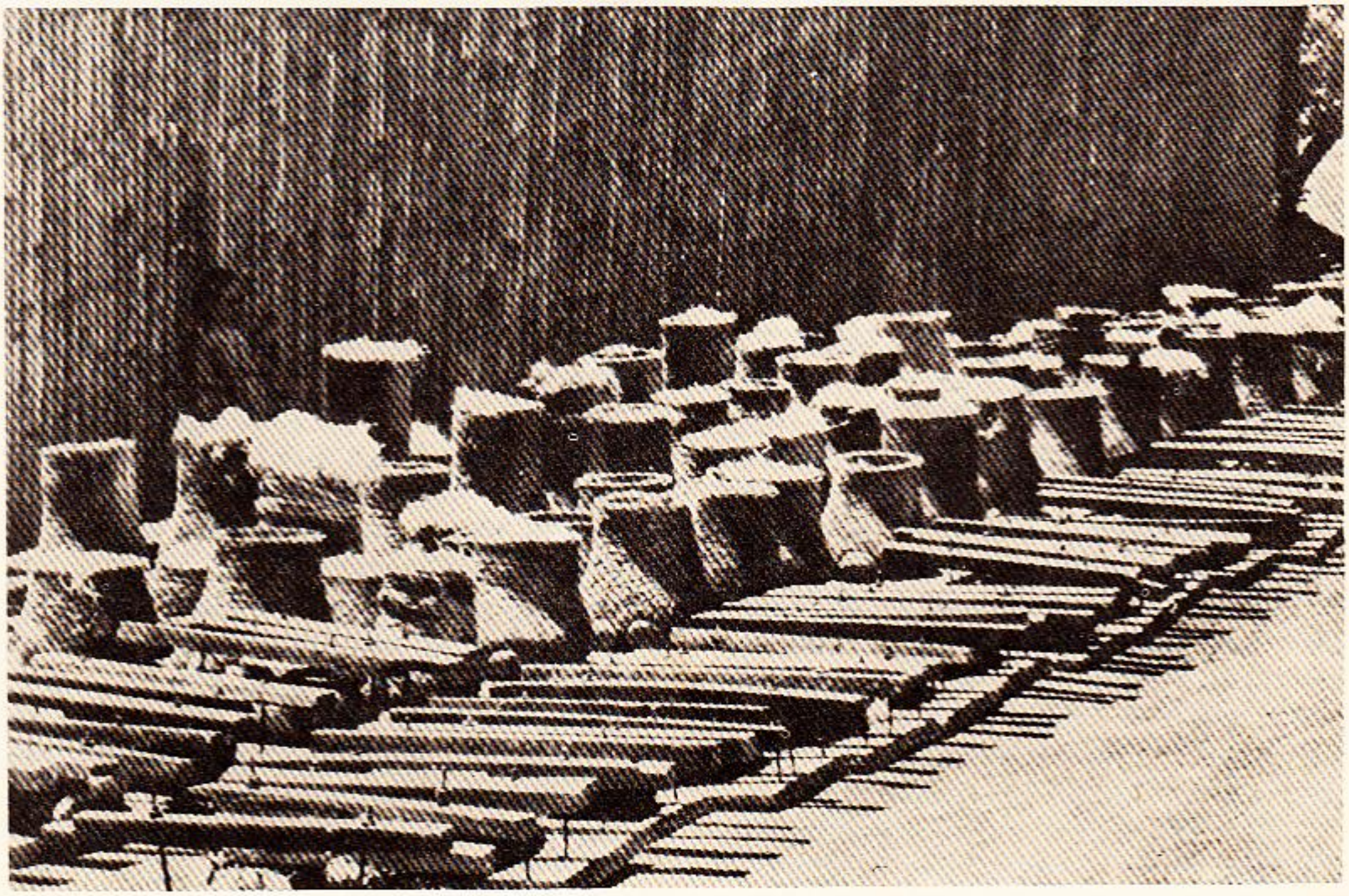
One elephant yields four waste-paper baskets! How very practical!

And rhinoceroses' feet make very good ashtrays. They are in great demand as well!

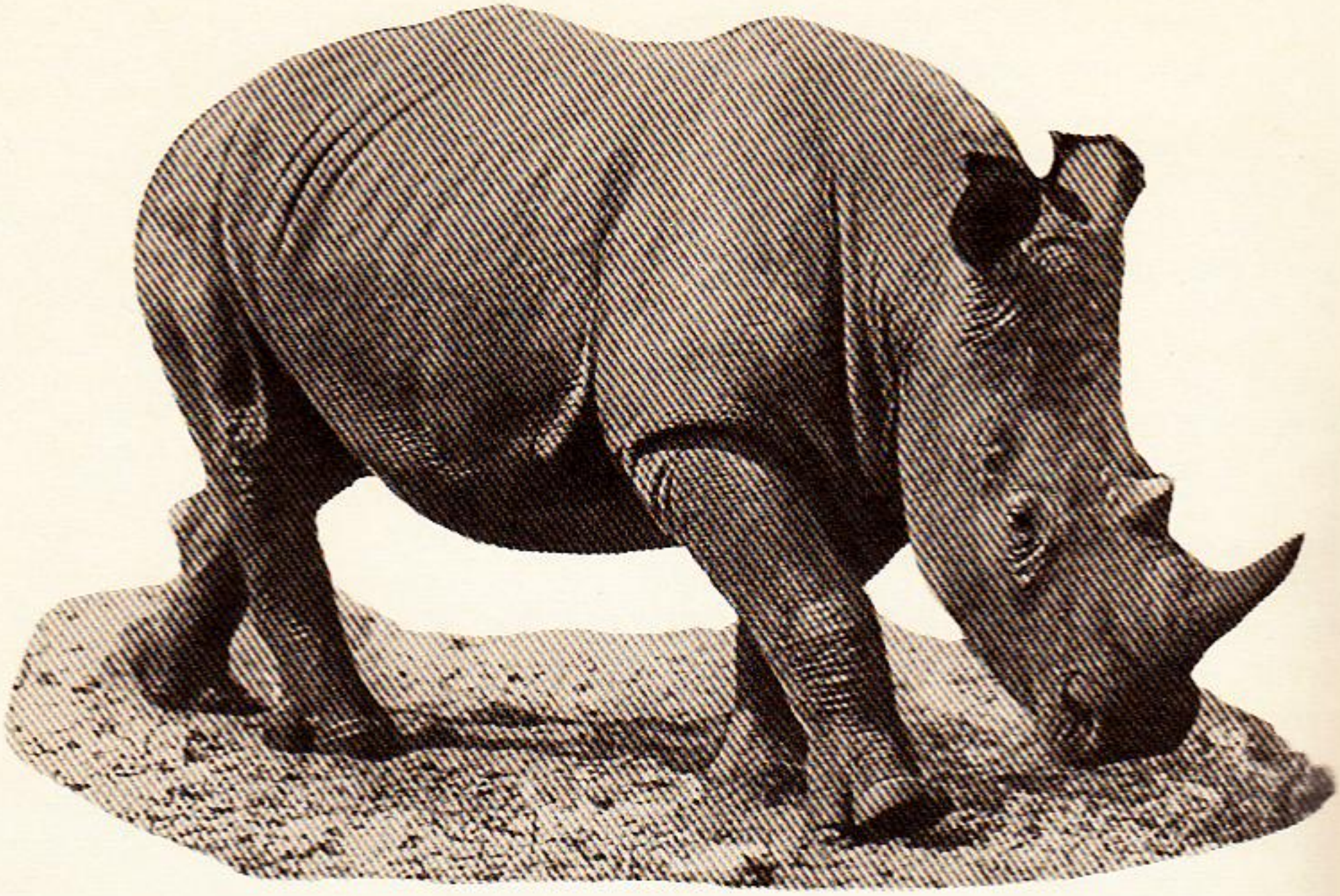
However, rhinoceroses are not only killed for the ashtrays. They are also killed for their horns. (Incidentally its horn is not properly a horn — it is not connected to the skull and does not have a bony foundation. A heavy blow can knock a rhinoceros's horn askew or tear it off altogether, but a year later a new one will begin to grow instead.)

Since ancient times, magical properties have been ascribed to this horn. It was considered that a goblet made of this horn protects its owner from poison: if poisoned wine were to be poured into such a goblet, it would break into pieces. (Another variant maintained the wine would go up in foam.) And since all rulers went in constant fear of being poisoned by their courtiers, there was a great demand for goblets of rhinoceros's horn.

Besides offering protection from poison, the horn was reputed to prolong one's youth and prowess. This belief in the rejuvenating properties of the horn is still alive in many countries of the East. There a rhinoceros's horn is



A profitable business, making waste-paper baskets out of elephants' feet. Such souvenirs are in great demand with tourists.



The killing of rhinoceroses is more profitable still; their horns are worth their weight in gold, and ash-trays made of the animals' feet are very popular with tourists.

literally worth its weight in gold. And so rhinoceroses, which were quite numerous in Asia and Africa until fairly recently, are becoming rare. Moreover, all five species of the rhinoceros (two live in Africa and three in Asia) are in danger of complete extinction. True, African rhinoceroses are less endangered than Asian ones. If timely measures are taken and the surviving animals are protected from the purveyors of magical horns, rhinoceroses have a chance to avoid extinction. But only if...

The situation with Asian rhinoceroses is much graver. The number of the great Indian rhinoceroses (the second largest after the white African rhinoceros) may be expressed in a three-digit figure.

Sumatran rhinoceros was destroyed almost completely by 1935. A herd of only 200 heads has been preserved on the Malay Peninsula and on the Island of Sumatra.

The third type of Asian rhinoceros, that of Java, used to be common on Java and adjacent islands, but now, only several animals remain on Java proper.

As recently as the 1920s, the Frenchman Cannon killed 350 rhinoceroses in four years. Incidentally, he was not after them specifically, for he was an elephant hunter and killed rhinoceroses only in passing, as it were.

But the Englishman John Hunter did kill rhinoceroses selectively, on assignment from the government of Kenya. In the two years of 1947 and 1948, he killed 800 rhinoceroses. And his total count reached 1,600 animals — twice as many as live in the whole of Asia today!

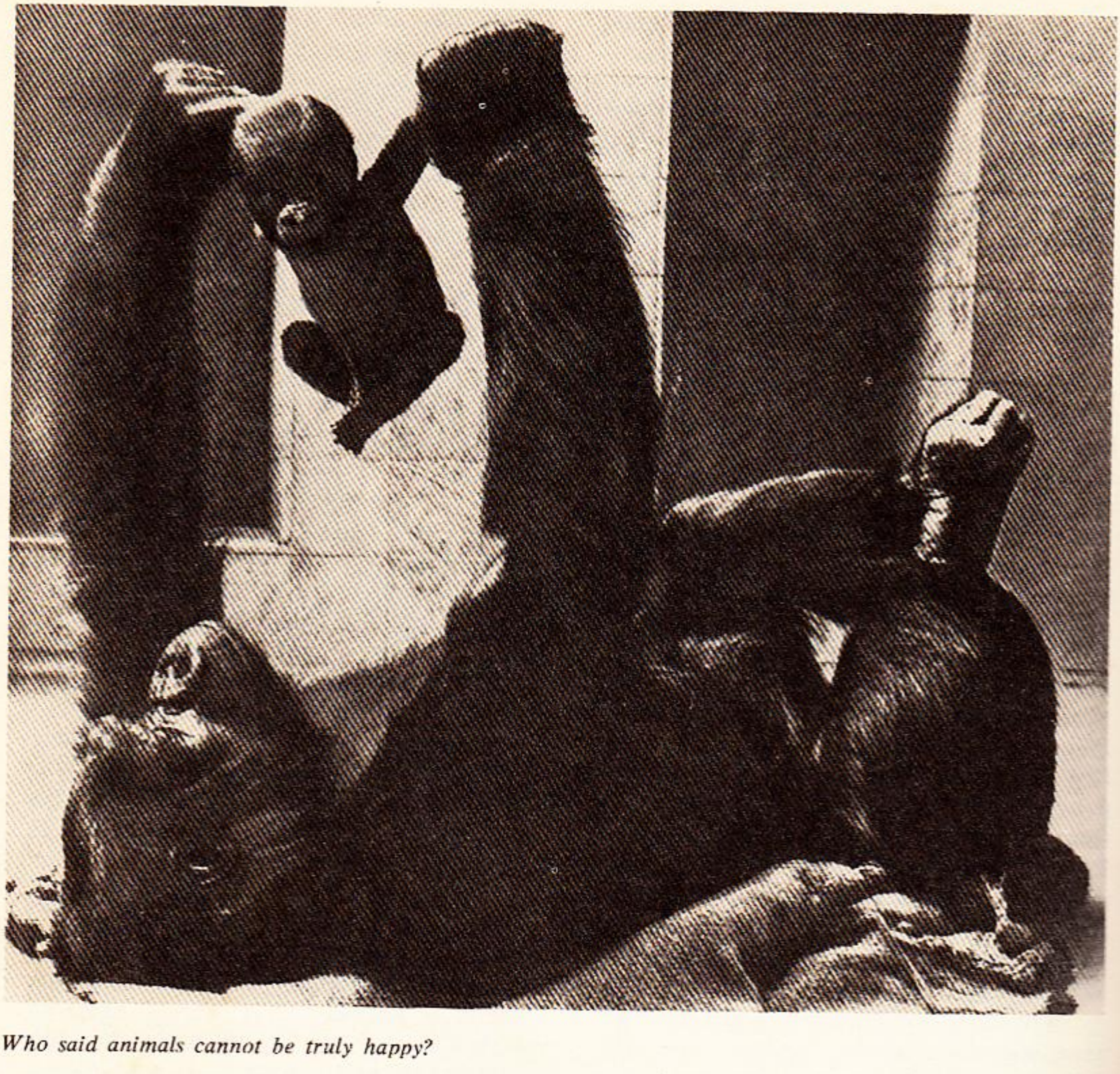
Our "Kinsmen" Are in Danger

Carl Akeley was a well-known naturalist and a talented sculptor. He was well known in the scientific world, and so it was no accident that the American Museum of Natural History commissioned him to go to Central Africa in search of mountain gorillas. Akeley instantly agreed. Naturally! These animals had only been discovered by Von Beringe two decades before, and very little was known about them. Akeley's assignment was to obtain several specimens for the museum. He fulfilled it, bringing with him five skins. Five stuffed gorillas appeared on exhibit in the museum. Five times Carl Akeley pulled the trigger. Five times he heard the cry of mortal agony. Five times he saw a large powerful animal drop from the tree, clutching vainly at the branches, and thrash convulsively on the ground.

Around stood beautiful trees, for the area was quite lovely. So lovely in fact that this killing seemed absolutely incompatible with it, especially when the victims were peaceable animals that never harmed anyone. Of course, the local people told tales of the gorillas' ferocity, and even showed scratches and bruises to support them, but Akeley did not believe in the gorillas' natural truculence (and he was right, as was later borne out by the observations of G. Schaller, who lived side by side with mountain gorillas for a whole year). Gorillas only attacked man out of fear, when defending themselves. Man, on the other hand, killed gorillas in cold blood. The same year Akeley went to Africa on assignment from the museum, the Swedish Prince Wilhelm was on the rampage in the same locality. The royal "hunter" killed 14 gorillas. Add to this the American Burbridge who did away with another 10 animals. In the course of a few years, 54 gorillas were destroyed in this small district — the last refuge of mountain apes.

Carl Akeley carried out the museum's assignment. But after delivering the skins of the gorillas he had killed, he returned to Africa at the dictates of his conscience. He returned there to try and protect the gorillas. He had seen the animals slaughtered and realised that if it kept up, the gorillas would disappear within a few years. He started a campaign in their defence. The Belgian colonial authorities were not particularly interested in zoology, but Akeley was persistent. Supported by other zoologists and nature lovers the world over, he carried the day: in 1925 the Belgian authorities set up the Albert National Park in the gorillas' habitat. Nobody knew how many gorillas had survived by then. To find this out and study the habits of gorillas, Carl Akeley came to Africa again in 1926. But he was not destined to see the animals to whose protection he had resolved to devote his life, for he died at the very beginning of the expedition.

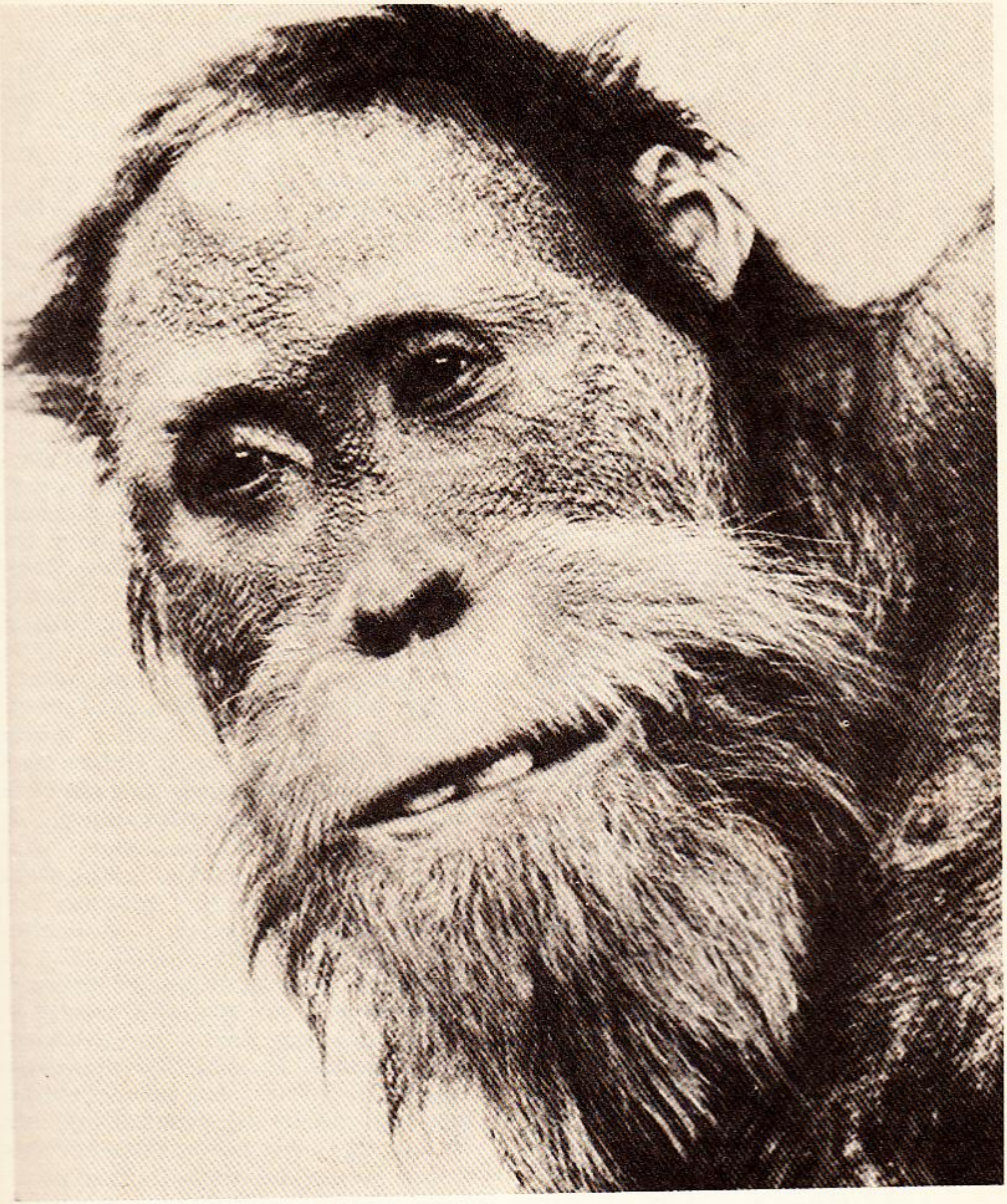
He was buried in the park which had been set up thanks to his courage and persistence. But shots still rang out over his grave: despite the official prohibition, the destruction of gorillas went on, and their population was quickly decreasing.



Who said animals cannot be truly happy?

Today, when young African states have received independence, nature protection in Africa has improved considerably. The Kivu National Park has been set up in place of the Albert Park. The animals in it have been declared national property. Let us hope that this will prove to be a stronger deterrent to poaching, and that our distant "relatives" will be saved from complete extermination.

But if mountain gorillas have been given a chance to survive, our other "kinsman", the orangutan, unfortunate-



The orangutan, "a man of the forest".

ly, has not, so far, a shred of hope.

Orangutans live on the islands of the Malay Archipelago. They were described by Alfred Wallace in his book *The Malay Archipelago: The Land of the Orangutan and the Bird of Paradise.* Since Wallace, people have learnt more about orangutans, but there is still quite a lot they don't know. And if a stop is not put to the destruction of orangutans, we are not likely to learn much more about the life and habits of these "men of the forest", as the Malays call these apes.

Orangutans live in inaccessible forests and rarely come down from trees. But even this has not saved them. Today there are no more huge herds of orangutans. Only small groups have survived, and they hide away in the remotest corners of the forest.

According to recent, not very reliable, estimates, several thousand of these apes still live on the Malay Archipelago. It is not much, but it means that orangutans have not yet reached the fatal line (2,000 animals) beyond which irreversible extinction begins. Still, orangutans are in mortal danger, and vigorous steps must be taken if we want to save them from total destruction.

Officially, hunting orangutans is outlawed. But poaching is rife, and there is no prohibition on the capture of live animals. Traders in animals avail themselves of this.

Orangutans are much sought by zoos. Today, about 250 orangutans live in various zoos. Their life expectancy in a zoo is no longer than 3 or 4 years, and in private menageries even less. It has been assessed that almost a quarter of all orangutans die in captivity every year. And every year, at least 60 new apes are bought by the zoos. Sixty is the nominal figure, but the number of orangutans captured must in fact be doubled, since every second baby orangutan (it is the young that are usually captured) dies on the way or during the very first days of its stay at a zoo. So the figure is in the vicinity of 120.

Nor is this all. Orangutans are devoted parents, and it is practically impossible to take a baby orangutan from its mother: she will defend it to her last breath, to her last drop of blood. Knowing this, the traders in animals, despite the prohibition, kill the mothers to get hold of young orangutans. So every baby sold means a mother killed. That makes the total figure 240. But there is no guarantee that the hunt is always successful. Sometimes the mother is not killed but only wounded and escapes into the forest to die there with her baby. Or the shot may kill or wound the baby instead of the mother. This brings the total to something like 300 animals a year. In ten years this will make 3,000. So if urgent measures are not taken, within ten or fifteen years, orangutans will reach the fatal line after which there is no turning back. Unless man helps his "kinsman", there may not be a single orangutan on earth in 20 or 25 years.

"The Fur Fever"

About 20 years ago, newspapers wrote about a film star who ordered a fur coat of tiger skins — for publicity, most probably. To satisfy her whim, ten tigers were killed — ten animals out of the very meagre tiger population left on the planet. But money talks, and the actress got her fur coat.

But should she fancy a chinchilla coat, no amount of money would do the trick — there simply are not enough

chinchillas left, so, according to the same newspapers, only three millionaires have been able to buy their wives chinchilla coats.

Perhaps there are a few more coats in existence, but still it seems incredible. For the chinchilla, an animal with the habits of a rabbit, was until quite recently common in the mountains of Peru, Bolivia and Chile. Travellers wrote about millions of these rodents populating the mountain slopes.

But the situation began to alter rapidly as soon as people came to appreciate the chinchilla's soft, beautiful, light and long-lasting fur.

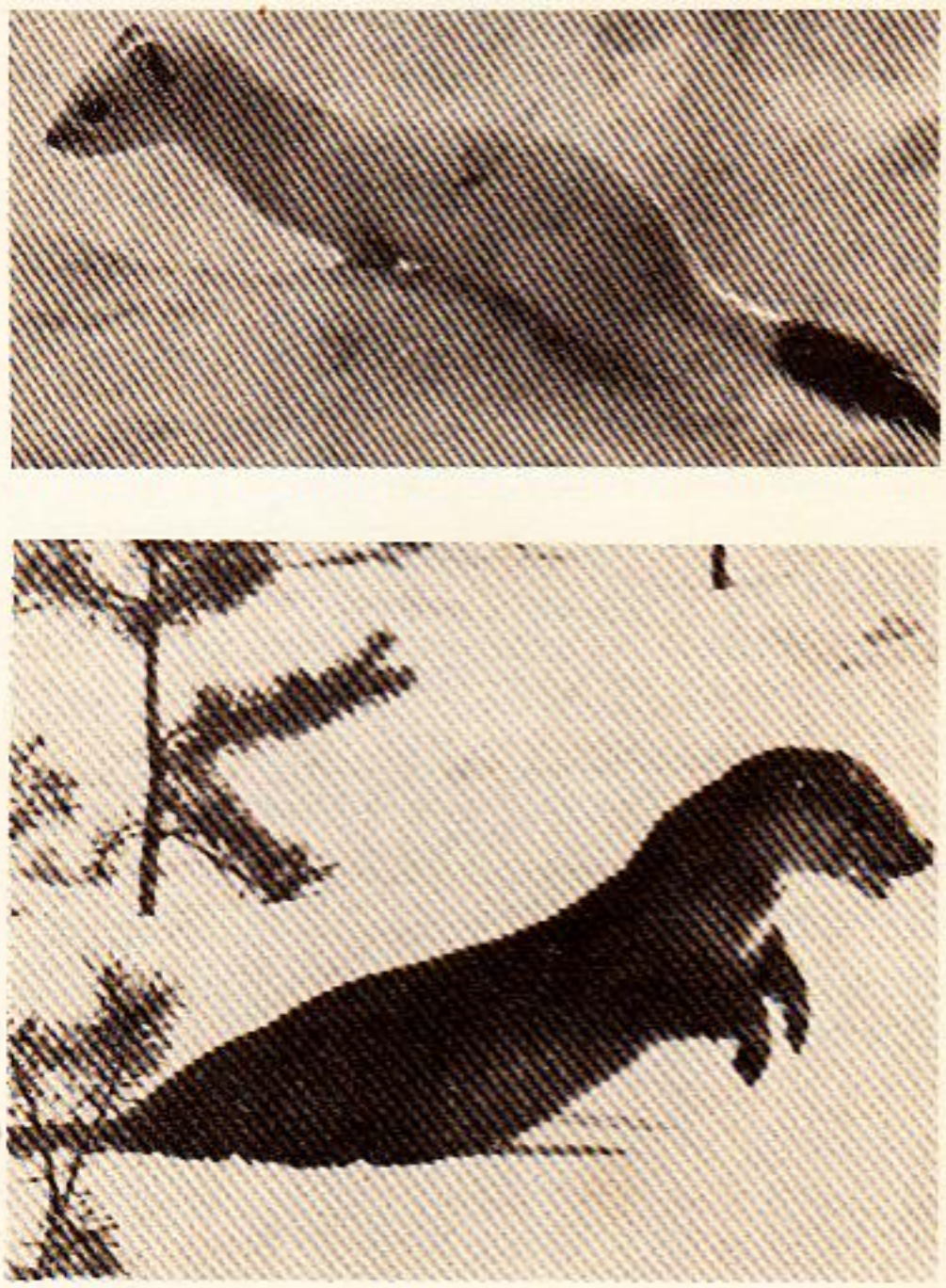
Actually, the Chinchas Indians living in those parts always wore clothes of chinchilla fur. The Incas who conquered the Chinchas also had a high opinion of the chinchilla. They not only made clothes of chinchilla skins, but even learnt to weave fabrics of chinchilla wool.

The Spaniards, who devastated the Incan state, brought chinchilla skins home among their most precious trophies. They were greatly admired in Europe, and barbarous extermination of these animals began forthwith. Ships sailed from America to Europe, their holds packed with chinchilla skins. Soon the numbers of chinchillas began to dwindle at a catastrophic rate. While in 1894, 800,000 chinchilla skins were exported from Chile, Bolivia and Peru, the figure for 1905 was only 400,000. Two years later the figure was halved again; a year later only 100,000 skins were exported, and in 1909, the figure was only 30,000 skins (not enough for a hundred fur coats!).

In 1918, the governments of South American countries had to adopt legislation prohibiting the shooting and trapping of chinchillas. But by then the animals had been almost fully exterminated. Only very small groups survived in Bolivia and the north of Argentina.

In the same year, the American Chapman, who had made a study of chinchillas, attempted to breed them in captivity. He spent several years "bringing chinchillas down" from the mountains — for chinchillas are accustomed to life at an altitude of 2 to 4 thousand metres above sea level. Over the course of six years, Chapman gradually transferred his farm lower and lower, inuring his charges to a different climatic conditions. In 1923 he finally brought 11 chinchillas to California.

Chapman was right in thinking that chinchillas breed quite well in



The ermine and the marten would have been fully exterminated for their warm, and handsome pelts had not man come to his senses in time.

This fur coat, probably the most expensive in the world, is an object of great pride for its owner. But animal-lovers have no warm feelings for the film-star at whose whim ten tigers were killed.

captivity. Thirty years later, there were 500 thousand animals on the fur farms of the United States and Canada.

Chinchillas have also been brought to Europe, and they are now bred in the Soviet Union, too.

Americans have even started selling chinchilla skins. But still, as a French newspaper put it, the possession of a chinchilla coat is "the most convincing proof of wealth".

But there are people, both in America and Europe, who are prepared to pay any sum for publicity, for a whim, or as a "convincing proof of wealth". Why then, if chinchilla coats are obtainable, albeit for a fantastic price, that so very few millionaires have been able to buy them?

The thing is that originally two types of chinchilla existed, the large short-tailed one and the small long-tailed one. It has proved possible to save the small long-tailed chinchilla, and it is this kind that is now being bred in captivity. The large short-tailed chinchilla, which yields the best fur, has not been saved. And only a few are known today to possess coats made of its skins.

Many animals fell victim to the "fur fever". The sable and the beaver were on the brink of extinction, as were many kinds of kangaroos and other animals that had the misfortune of possessing warm and handsome coats. One of them was the lovable little animals of Australia, the koala.

The koala is a marsupial bear. It is much like the teddy bear, though, admittedly, a big one: the grown koala weighs some 15-16 kilograms.

Koalas are amazingly gentle and peaceable animals. They say it is virtually impossible to make a koala angry. They do not run away from people and even allow themselves to be picked up. (True,

Kangaroos are still quite numerous in Australia. Still, the Australian government had to adopt a law protecting these animals to make sure that future generations too are able to see them not only in zoos and on photographs.

Gerald Durrell has a different opinion of koalas, but he was probably just unlucky — after all there are bad-tempered individuals among animals as well!) In general, koalas cannot move very fast while in trees, but down on the ground, they are quite spry. However, they spend most of their time crawling from one tree to another, often with their cubs riding piggyback. As with all marsupials, a koala's babies spend the first months of their lives in the mother's pouch, but when they grow up a bit, they move to her back and travel about in this fashion until they are three years of age. The mother carries about the almost grown cub uncomplainingly, and sometimes is encumbered with several of different ages and sizes.

At one time the koala was Australia's most common animal. The aborigines treated it very well. Of course they hunted koalas, but only within reason.

Extermination of koalas started with the arrival of the white settlers. They not only liked the taste of koala's meat, they realised that the animal's thick and handsome fur would fetch a good price.

And then the wholesale slaughter of koalas began.

Koalas did not hide or run away. Defenceless, a live target, they only cried out piteously when wounded, and their cry was much like that of a human baby. But the butchers were not bothered by pangs of conscience. So the "teddy bears" flopped to the ground, and if a wounded animal clung to the branches the hunters did not even take the trouble to bring it down — why bother when there were so many around?

So boats sailed from Australia with cargoes of koala skins.

It is impossible to take koalas out of Australia alive: they will die on the road, for their staple diet is fresh eucalyptus leaves. And there are different kinds of eucalypti in different seasons.

Little was known about koalas in Europe and America. And it might well have been that the animal would have died out before it was properly studied, for in 1924, two million koala skins were exported from Australia. In 1927,

This lovable and good-tempered animal, the koala, was at one time on the brink of extinction.

in the state of Queensland alone, 600,000 koalas were killed. Then, on top of this, an epidemic broke out among koalas.

As a result of this all, no more than several dozen koalas were left in the whole of Australia. It was only then that the Australian government issued a stern law protecting the koalas, and special reserves were set up.

The measures taken proved effective. There is every reason to hope that the loveable animal which at one time was on the brink of extinction will not share the fate of many animals known to us only from stories, drawings and stuffed skins.

In Only Twenty-Seven Years...

In November 1746, Georg Wilhelm Steller, the only naturalist who saw the sea cow alive, died at the age of thirty-seven on the way back to St. Petersburg. These animals subsequently came to be known as Steller's sea cow. But at the time the name was given them, there were no longer any sea cows in existence. Twenty-seven years after man first set eyes on them, in the year 1768, the last sea cow was killed. Their tender, tasty meat and trusting nature proved their undoing. They were killed in such numbers that by 1754, the Russian officer Pyotr Yakovlev, after witnessing their slaughter, suggested that the hunting of sea cows should be prohibited. That was only 13 years after Georg Steller first saw these animals.

He saw them in November 1741, when the surviving members of Vitus Bering's expedition landed on some deserted shore. At first, the seafarers believed they had landed on the coast of Kamchatka, but they were mistaken — it was an ininhabited island unknown to geographers. Bering's people found themselves in desperate straits. Almost all of them went down with scurvy. Steller was also ill, but, a doctor and a naturalist, he continued taking care of his patients and writing a detailed diary. In this diary, he wrote that on the very next day after the landing, they saw large marine animals science knew nothing about not far from the shore.

These animals were so trusting that they not only permitted Steller to take a very good look at them but did not even mind his stroking them from his boat which he took into the very thick of the herd.

Yes, they presented a fascinating sight to the naturalist. In front, they resembled seals, but in the back, they had a fish's tail with fins placed not vertically, as in fish, but horizontally, as in whales. The animal had a small head and a prominent upper lip which was split in the centre. The front flippers, a metre and a half long, were also forked and very mobile. The animal used them not only for purposes of swimming but also in feeding: it caught sea weeds with the flippers, put them into its mouth, and strained them through the split lip. As a result of this procedure, the soft parts remained in the mouth and the hard parts were pulled out by the flipper and thrown away.

The strange animals were not in the least afraid of man, grazed peacefully in his presence by the shore (for the weeds that formed the sea cows' diet only grew right by the shore) and sometimes raised their heads from the water and made funny sneezing sound, much like a horse would. Even when a sea cow was hurt, it did not

This lovable and good-tempered animal, the koala, was at one time on the brink of extinction.

in the state of Queensland alone, 600,000 koalas were killed. Then, on top of this, an epidemic broke out among koalas.

As a result of this all, no more than several dozen koalas were left in the whole of Australia. It was only then that the Australian government issued a stern law protecting the koalas, and special reserves were set up.

The measures taken proved effective. There is every reason to hope that the loveable animal which at one time was on the brink of extinction will not share the fate of many animals known to us only from stories, drawings and stuffed skins.

In Only Twenty-Seven Years...

In November 1746, Georg Wilhelm Steller, the only naturalist who saw the sea cow alive, died at the age of thirty-seven on the way back to St. Petersburg. These animals subsequently came to be known as Steller's sea cow. But at the time the name was given them, there were no longer any sea cows in existence. Twenty-seven years after man first set eyes on them, in the year 1768, the last sea cow was killed. Their tender, tasty meat and trusting nature proved their undoing. They were killed in such numbers that by 1754, the Russian officer Pyotr Yakovlev, after witnessing their slaughter, suggested that the hunting of sea cows should be prohibited. That was only 13 years after Georg Steller first saw these animals.

He saw them in November 1741, when the surviving members of Vitus Bering's expedition landed on some deserted shore. At first, the seafarers believed they had landed on the coast of Kamchatka, but they were mistaken — it was an ininhabited island unknown to geographers. Bering's people found themselves in desperate straits. Almost all of them went down with scurvy. Steller was also ill, but, a doctor and a naturalist, he continued taking care of his patients and writing a detailed diary. In this diary, he wrote that on the very next day after the landing, they saw large marine animals science knew nothing about not far from the shore.

These animals were so trusting that they not only permitted Steller to take a very good look at them but did not even mind his stroking them from his boat which he took into the very thick of the herd.

Yes, they presented a fascinating sight to the naturalist. In front, they resembled seals, but in the back, they had a fish's tail with fins placed not vertically, as in fish, but horizontally, as in whales. The animal had a small head and a prominent upper lip which was split in the centre. The front flippers, a metre and a half long, were also forked and very mobile. The animal used them not only for purposes of swimming but also in feeding: it caught sea weeds with the flippers, put them into its mouth, and strained them through the split lip. As a result of this procedure, the soft parts remained in the mouth and the hard parts were pulled out by the flipper and thrown away.

The strange animals were not in the least afraid of man, grazed peacefully in his presence by the shore (for the weeds that formed the sea cows' diet only grew right by the shore) and sometimes raised their heads from the water and made funny sneezing sound, much like a horse would. Even when a sea cow was hurt, it did not

try to retaliate but simply swam away, soon forgetting the wrong done it, forgiving the offender, kind-hearted creature that it was, and coming back.

After they had eaten their fill, the sea cows would swim farther out to sea, turn over on their backs, and rest in this position. They kept together in a herd, but maintained family groups — a father, a mother and a baby, the latter emitting soft squeaks. The grown animals did not make any sounds at all. Even when wounded and dying on the shore they only sighed heavily

The cub of a fur-seal.

and gazed at people reproachfully with eyes full of mortal anguish. Even the stern sailors, who had barely escaped death themselves, who had buried their commander and many comrades, could not bear the sight. Although the sea cows' flesh and fat were very tasty, they practically stopped hunting them, especially after they became aware of the loyalty these animals exhibited toward one another. Sea cows never abandoned a friend in distress: they tried to extricate harpoons, to break the ropes attached to their fellows or to overturn the boat the hunters were in. If the harpoon hit a female, her mate would go berserk: he forgot about his own safety completely, paid no attention to the blows dealt him by the hunters, and tried with all his might to chase the men away from the wounded female. Nor would he abandon her when she died. He would remain beside her dead body on the shore for two or even three days.

The remnants of Bering's expedition not only brought back news of the sea cow; they also brought the valuable skins of the sea otter. At once, fur-traders dashed north to hunt these otters. Nor did they need to take a lot of provisions along: the trusting and utterly defenceless sea cows, obliged to keep near the shore, where their food was, were easy prey and provided lots of good meat.

So the slaughter started — needlessly cruel, senseless and disgusting. In a mere twenty-seven years, Steller's sea cow was totally exterminated. All we have left of this animal are several skeletons preserved in museums.

True, from time to time reports reach us of meetings with animals resembling Steller's sea cows. Perhaps they lived in other localities as well, not just near the island which later came to be known as Bering Island. Perhaps people are still destined to see a live Steller's sea cow, and future generations will even succeed in taming them.

The thought certainly warms one's heart.

Not only ladies of fashion but even knights and kings used to decorate themselves with birds' feathers. An old engraving.

Cranes Under Escort

Twice a year, in spring and in late summer, the radio and television of the United States begin broadcasts about the white American crane, urging people to protect these birds. The broadcasts start as the cranes prepare to make their annual flight from South Texas and Arkansas to Canadian swamps and on their return flight. An airplane accompanies these handsome and very rare birds to their summer or winter quarters, where they will be guarded round the clock by watchmen on the ground. And still, it is unlikely that the species would have survived, despite the aerial escort, had not a special preserve been set up.

Hundreds of perils threaten the birds during migrations, of which the direst is the bullet of the poacher. The poacher does not watch TV or listen to the radio, and even if he does, he cares nothing about preservation of rare birds. All he is concerned with is their handsome plumage which fetches good money. Handsome plumage has proved the undoing of many species of birds, some disappearing from the face of the earth altogether, others dwindling in numbers until they reached the threshold of extinction.

The Carolina parakeet, the only species of parrot endemic to the United States, no longer occurs in America. The same is true of the condor of California, the largest bird of North America, and even of the bald eagle which appears on the coat-of-arms of the United States.

Birds were exterminated to adorn ladies' hats with beautiful feathers. Had it not proven possible to breed ostriches on farms, we would only know of this bird from word of mouth. Indeed, in the year 1875 alone, more than 14,500 kilograms of ostrich feathers were exported from Africa to Europe. In the beginning of this century, 400,000 skins of the humming-bird were delivered to London and 50,000 of birds of paradise were brought from Polynesia. As for other birds killed for the sake of whim and fashion, their numbers cannot even be counted. What we can assess though is the number of species already extinct or nearing extinction.

Very characteristic in this respect is the story of the short-tailed albatross.

These birds built their nests on some of the islands in the Pacific Ocean. Much to their grief, they had beautiful

plumage. And so the traders rushed to the islands.

The albatross is an indefatigable flyer that does not fear any winds, not even a gale. But during nesting, the birds are practically helpless. Generally, the albatross, being a heavy bird, takes wing with considerable difficulty. And when it is sitting on its nest, it makes no attempt to fly away, even when it is in mortal danger but heroically defends its single egg or its only fat and helpless fledgeling.

The purveyors of albatross feathers used this characteristic behaviour for their own foul ends. They came to the islands before or just after the eggs were hatched and killed the birds on their nests with long sticks. In a single day, one such "hunter" disposed of some hundred or two hundred birds, and if we count the doomed fledgelings, the figure must be doubled. In the course of 17 years, from 1887 to 1903, no less than 8.5 million adult birds were destroyed on the islands (17 million if we count the fledgelings). The last of them were killed off just before the Second World War.

Barbarian destruction of birds, which involved the death of the fledglings as well, resulted in the almost complete extinction of white herons, which have especially beautiful plumage during the mating season. Several long, handsome feathers were pulled out and the rest thrown away. In Venezuela alone, a million and a half white herons were killed every year.

But birds were killed not only for the sake of their plumage.

People had just a hundred years to study the cormorant discovered by Georg Steller. In 1850 Steller's cormorant ceased to exist; it was killed off in toto by hunters.

Linnaeus just managed to describe the wingless auk. A hundred years later not a single auk was left on Earth. The last pair was killed in 1844.

The year 1852 saw the complete extermination of the Labrador eider, prized for its meat and down. Hunters would raid colonies and kill thousands of birds at one go. This fate befell other birds besides the eider. Below is a description of a hunt for the black-capped petrel, a bird exterminated several decades ago:

"Each hunter was armed with a long pole seven or eight feet long, the thickness of a finger and with a hook at the end. Our dogs ran ahead dashing here and there. When they caught the scent of 'the devil' in its hole (and the entire slope was pockmarked with holes) they began to dig... The hunter poked his pole deep into the hole, trying to get at the bird. The bird would clamp down on the pole and would rather let its throat be cut than unclasp

its beak. When it was lifted to the opening of the hole, the light dazzled it, and it shut its eyes and tried to back away, but the hunter put his foot in its way. The bird then flopped on its back to defend itself with its claws and beak. Then the hunter chose a moment to wring its neck..."

But for sheer brutality, the extermination of wingless auks, large birds with underdeveloped wings, growing up to 75 centimetres in length, beats all records. Auks were common all over the globe, and they were known to people from time immemorial. We find their bones on the kitchen middens of primitive people.

In later epochs, too, the wingless auk was a constant source of meat and fat, but their numbers were not depleted, for the local population killed only as many "spear-birds", as they were called in some regions for their long and sharp beaks, as they needed for food. But then traders appeared, and this spelled the auk's doom. The first step was made in 1590 by an enterprising Irishman who brought a cargo of auks from Greenland. And then the extermination snowballed. It was soon realised that the best time to hunt the auks was during the nesting period when the birds gathered in large colonies on the shore and sat on their nests immovably warming the only egg or protecting the only fledgeling. People came with sticks and stones and the helpless birds would dash about in a panic to the delighted yelling of blood-crazed killers.

At first, auks were hunted by pirates and sailors who needed to replenish their stocks of provisions. Easy prey intoxicated people; the power of death over helpless creatures went to their heads; and they would kill many more birds than they really needed — than they could even take along in their boats.

Sailors and pirates gave way to meat-traders, who were quick to realise the profits these fat birds promised. They killed in cold blood, with the price of each blow on the head calculated in advance.

The two fatal years were 1808 and 1813, when two large ships went auk-hunting in Greenland. Auks were killed with sticks, choked with bare hands, stamped with feet. The shores of the Island of Geirfuglasker were slippery with broken eggs and smashed fledgelings.

After that slaughter, the numbers of auks began to dwindle fast, and in 1834, the bird disappeared altogether. The search for it went on, because collectors were prepared to pay big money for the extinct bird.

And so in 1844, two more birds were obtained — the last two surviving wingless auks.

In 1909, zoologists were offering a prize to anybody who could find a nest of another species of birds whose numbers were assessed at several billions short time before. This was the so-called passenger pigeon.

A hundred years before the prize was announced, an American zoologist saw a flock of passenger pigeons which included, according to his rough estimate, some 2,230,272,000 birds. And there were many such flocks. Another zoologist estimated that at least 136 million pigeons built their nests in a wood with a territory of 2,200 square kilometres. Other data related to the flocks and colonies of passenger pigeons are all expressed in seven, eight or even nine digit figures. When a flock of pigeons flew over a locality, it was as if

The photograph of the last passenger pigeon on Earth.

dusk had fallen, and when they stopped for the night, there were not enough twigs in the wood for perches, so the pigeons would have to sit in several rows one on top of the other. Sometimes even thick boughs broke under their weight, although each bird weighed no more than 200-250 grams.

It would seem that birds occurring in such vast numbers need not fear any vicissitudes of fate. Of course, such huge flocks needed great quantities of food, but they did not suffer from any scarcity of it — they ate acorns and seeds of wild trees, and there were plenty of forests along their migration routes. Nor did they seem to fear hunters, finding safety in numbers. Yet thirty years later, a prize was being offered to anyone who could find a pigeon nest. Only thirty years! But what carnage those years had seen!

The American Indians had long known that passenger pigeons had tasty meat. But the Indians respected the laws of nature and never killed more birds than they could eat. Besides, they never hunted during the nesting season. Not so the white settlers, who had no regard for any laws whatever. Indeed, it was impossible to shoot at a flock and miss. And shoot they did. People brought birds down with sticks, stones, and oars. Thousands, many thousands of pigeons would be lying on the ground, but people went on killing more and more. Soldiers fired on them with case-shot and provided supper for a company with one shot. Farmers knocked pigeons down with poles and boards and netted them easily. The passing of these pigeons was awaited and prepared for, with stocks of stones put up, nets prepared and barrels made ready for the salting of pigeon meat.

Connoisseurs soon discovered that the best and fattest meat was that of young birds, not yet able to fly. So whole expeditions set out for pigeons' nesting places. Nests were knocked down with poles and the fledgelings' necks wrung. If the poles were not long enough, the hunters felled the trees.

Pigeons were killed by hundreds of thousands, but this was still "small fry". The real extermination began when the "professionals" appeared on the scene. A clear-cut system was developed. Special scouts sought out the pigeons and then telegraphed the whereabouts of a flock. A detachment of hunters would be despatched there armed with rifles. Now the doom of the passenger pigeon was sealed. Suffice it to say that in one hunting season, a million and a half pigeons were shot in the one state of Michigan. Several years of such hunting put an end to large flocks. By 1880, only small flocks continued to migrate about the country, and by 1902 passenger pigeons were destroyed completely.

The prize of 1,500 dollars was offered for a passenger pigeon in 1909. Pigeon "specialists", who had only recently killed these birds by the thousand, now started looking for survivors. But the prize was never claimed — there were no longer any pigeons left.

Some birds lived out their days in zoos, but they did not linger long. The last passenger pigeon died on September 1, 1914 in the Cincinnati Zoo.

Such was the end of the terrible story of the passenger pigeon — unfortunately, not the only one of its kind.

TO SUM UP THE PREVIOUS CHAPTER AND INTRODUCE THE NEXT ONE

In addition to the tragedies described in the preceding chapter, man has perpetrated many more crimes against animals. The International Union for Conservation of Nature and Natural Resources has compiled a special *Red Data Book*. Included in it are all animals whose numbers have dwindled to the fatal line of 2,000. If there are only 2,000 animals or fewer left, it means urgent measures must be taken unless we want them to disappear from the face of the earth.

The list of animals already extinct or nearing extinction occupies two fat volumes; both are bound in bright-red cloth. Red was not chosen arbitrarily. It represents a warning signal, a red light. "Stop!" it says. "Take urgent measures at once!" Today 200 species of mammals and more than 300 species of birds are endangered. And the list, sadly, continues to grow.

Far from all have taken heed of the warning light of the *Red Data Book*.

Extermination of animals for whim, money, out of ignorance, or for the sake of fashion is a crime that cannot be justified.

But guns continue to boom, and rare animals and birds continue to die. Mankind is still largely indifferent to the fate of animals. One reason for this indifference is perhaps unawareness of the scale of the calamity.

Gerald Durrell wrote about a certain member of the government of New Zealand who said he saw no reason for worry even if the rare albatross nesting on some islands off New Zealand disappeared altogether — after all, people practically never visited those islands!

If a minister can be so obtuse, what can you expect from people who have been killing animals for food all their lives, who regard wild animals as so much meat?

No wonder, therefore, that even those species of animals which are in no danger of extinction so far should be speedily dwindling in numbers. Such was the case with water goats in the valley of the Kafue River in Africa. The local people used to organise hunts which were called "blood-baths". Hunters with dogs drove huge herds into the water and killed thousands of animals, mostly females with young.

Well, one can hardly blame the Africans — they simply need food. In many African languages, the word for "animal" and "meat" is the same.

But the problem could be solved in an entirely different manner. Zoologists have estimated that no less than 20 thousand water goats could be killed for food every year with no harm done to the species. This would yield some 2,000 tons of meat. But while people responsible for the fates of wild animals are trying to work out a solution, poaching runs rife in many countries where rare and valuable animals live. In the national park of Serengeti alone, poachers kill 150-250 thousand animals annually. And their methods are cruel in the extreme. The animals they capture die slowly in pits and wire nooses that abound in the park. In trying to free itself, the animal pulls the noose ever tighter, the wire cuts into its body, the animal writhes and thrashes in pain and panic until it dies, often becoming the prey of hyenas or vultures.

There is another method employed by poachers to catch zebras and antelopes. They drive the animals into nets stretched between trees and cut the tendons in their legs. The immobilised animals serve as living "game preserves" for their tormentors, who kill one whenever they need fresh meat.

And what about white hunters with their perfect instruments of killing? Even the most nimble-footed of animals cannot run away from them. These hunters never see the desperate plea in the eyes of a zebra or an antelope: what have I done to you? Why are you killing me?

Still and all, mankind's conscience is showing signs of awakening. Interest in animals and respect for them is growing. More and more people want to see not stuffed animals and not their skins, but live, free creatures. Testimony to this is the eightfold increase in visitors to zoos and the growing numbers of enthusiasts who form societies for the protection of animals in general and individual species in particular. Testimony to this, finally, is the legislation passed by governments of many countries and international agreements on nature protection.

But this is just the beginning, the first step.

Protection of animals involves many problems, beginning with how to keep them off the roads, when cars kill them by the thousand. Agricultural machines do their share of damage, too. One of the final steps in conservation is the setting up of special preserves; there is also the problem of breeding rare animals in captivity and that of preserving the proper natural conditions so rare animals and birds can live in the wild.

There are scores of problems and very little time, for the earth's fauna is growing scantier with each passing year.

Many animals will never be saved and will not reach the 21st century. But at least people must do everything in their power for those animals which it is not yet too late to save.

FOR IF OUR BEAUTIFUL ANIMALS
AND BIRDS CEASE TO EXIST, LIFE
WILL AT ONCE BECOME DULL AND
COLOURLESS.

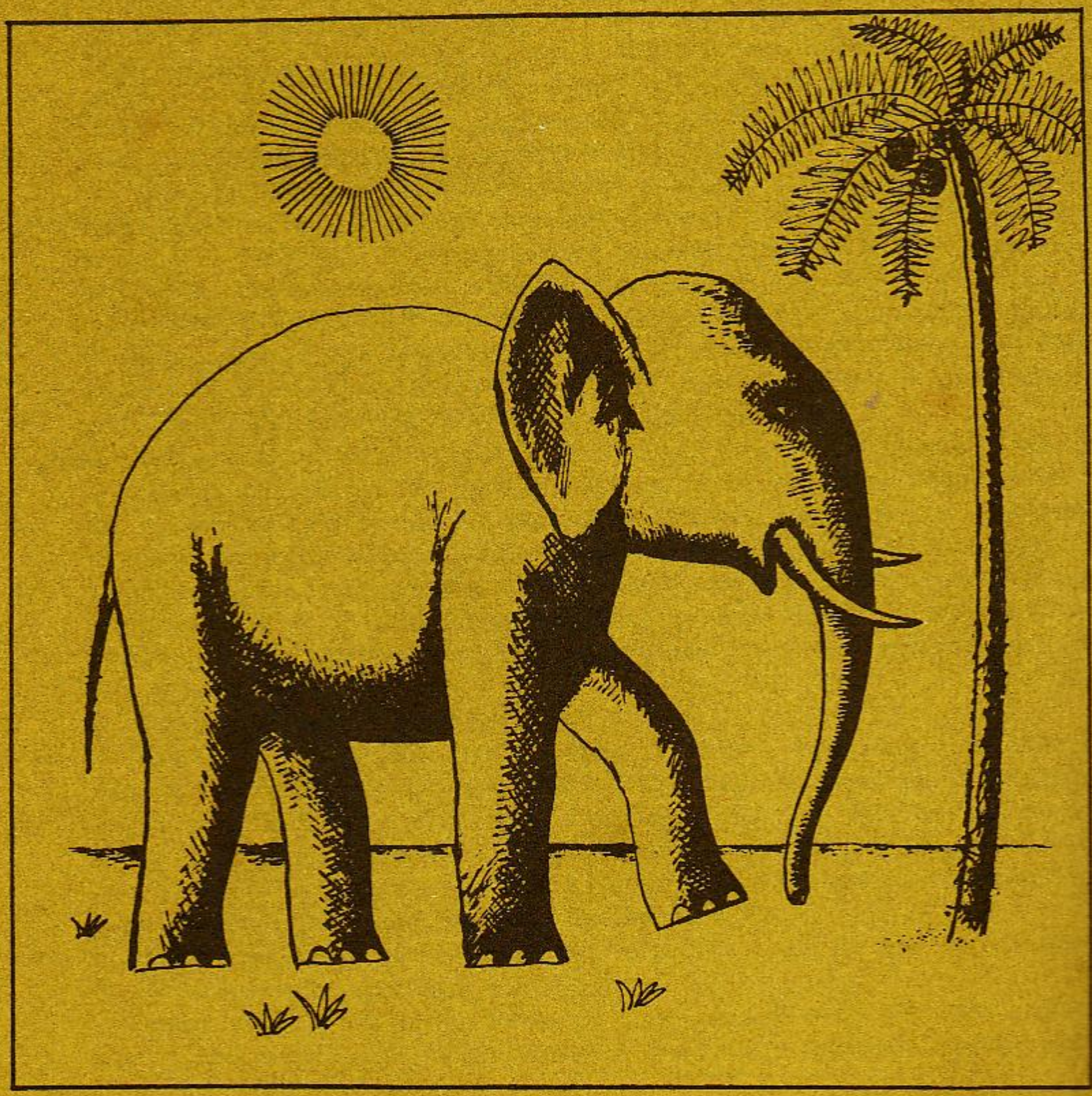
Jawaharlal Nehru

THE SYMPATHY WHICH MAN FEELS
FOR ALL LIVING CREATURES IS
WHAT MAKES HIM TRULY HUMAN.

Albert Schweitzer

6

Man Protects and Saves



Once in 1919...

In the very beginning of 1919 a certain person by the name of Nikolai Podyapolsky arrived in Moscow from the city of Astrakhan, then besieged by the White Guards. He was an agronomist by education and a nature conservation enthusiast. Upon his arrival, he at once went to Anatoly Lunacharsky, the People's Commissar for Education, whom he had known before the revolution. He told him briefly how he had escaped from encircled Astrakhan and eventually reached Moscow, and laid on the Commissar's desk the document for the sake of which he had undertaken this dangerous journey.

Lunacharsky scanned the document, raised his head, gave Podyapolsky a keen look through his pince-nez, and began to read it a second time, slowly and carefully.

Afterwards, they had a long talk, which continued far into the night at Lunacharsky's home. The next day, Lunacharsky told Lenin about the guest from Astrakhan and about the document he had brought — a plan for setting up a nature preserve in the delta of the Volga. The plan had been considered and approved in Astrakhan and Podyapolsky had been despatched to Moscow with it.

On January 16, Lenin received Podyapolsky.

The immence natural riches of the Volga delta had seemed inexhaustible. And people had been laying waste to them. Birds were caught during moulting, with as many as 1,000-1,500 helpless ducks driven into nets at a time. Eggs were gathered and sent to soap factories; on orders from agents of French firms the remarkably beautiful white heron was killed *en masse* to obtain feathers for ladies' hats. The French were generous, paying enough for 3 or 5 heron skins to buy a cow.

Not only birds were being destroyed: the reeds were set on fire to drive out wild boars; river arms were completely cut off with nets during the spawning migration of fish, and in winter fish were scooped out of wintering holes.

Podyapolsky spoke to Lenin of this and many other things. After hearing him out, the leader of the Soviet state said:

"Protection of nature is important not only for Astrakhan territory, but for the entire Republic. I attach great significance to it."

It was snowy January outside, the first month of the year 1919, a crucial one in the life of the young Soviet Republic. Still Lenin regarded nature protection as not merely a timely but an urgent undertaking.

Russia had always been a country of stupendous riches and stupendous waste. Nobody knew how many animals and birds lived on its vast expanses; nobody had even so much as tried to get a rough estimate of their numbers or to ascertain at what rate they were being destroyed. As the result some animals were already rare in the distant past. A beaver, for instance, cost more than two cows or a horse, or even a serf as far back as the llth century. The illegal killing of a beaver was punished by a fine of 12 *grivnas* (pieces of silver). On the other hand, pelts (of squirrel or marten) were accepted as monetary units as well.

Princes collected tribute from conquered tribes in the form of valuable pelts. Russian ambassadors abroad were given a supply of fur pelts to use instead of money.

Naturally, all this caused the numbers of animals, especially fur-bearing ones, to dwindle rapidly. Some were exterminated altogether. In those far-off times, attempts were already being made to ensure the multiplication of animals, and laws were even passed forbidding or limiting the hunting of some species. But it was virtually impossible to enforce these laws in the country's virgin forests. So thousands of hunters shot animals, set traps and dug pits. According to Russian writer and scholar Vladimir Dahl, every professional hunter had as many as a thousand traps on his territory.

Meanwhile, the demand for furs kept growing, especially when trade with foreign countries was started on a permanent basis.

Peter the Great was well aware of the dire consequences of the indiscriminate extermination of animals. In 1696, he issued an ukase which declared all sable pelts government property. In 1701, another ukase was issued — "On the Cessation of Export of Beaver Pelts Overseas", and in 1714, Tsar Peter was forced to forbid the hunting of elks in St. Petersburg Gubernia.

However, these ukases, as well as other laws and regulations passed in later years and aimed at curtailing hunting and protecting animals had very little effect. Nor did legislation against poaching help much. Although in 1635, the Russian Tsar decreed that those people who "do harm to animal hunting" should be punished by "cruel whipping", and even though Peter the Great enforced a fine of 100 rubles on "people of higher ranks" for poaching, while the "lower ranks" were threatened with exile, although many other threats were made (for instance, in 1773, Catherine the Great issued an ukase which stated that "elks should not be shot, caught or killed in any season by any person whatever"), in 1845 the Russian zoologist Karl Rulier established that there were no elks in Moscow Gubernia any longer and very few were left in neighbouring provinces.

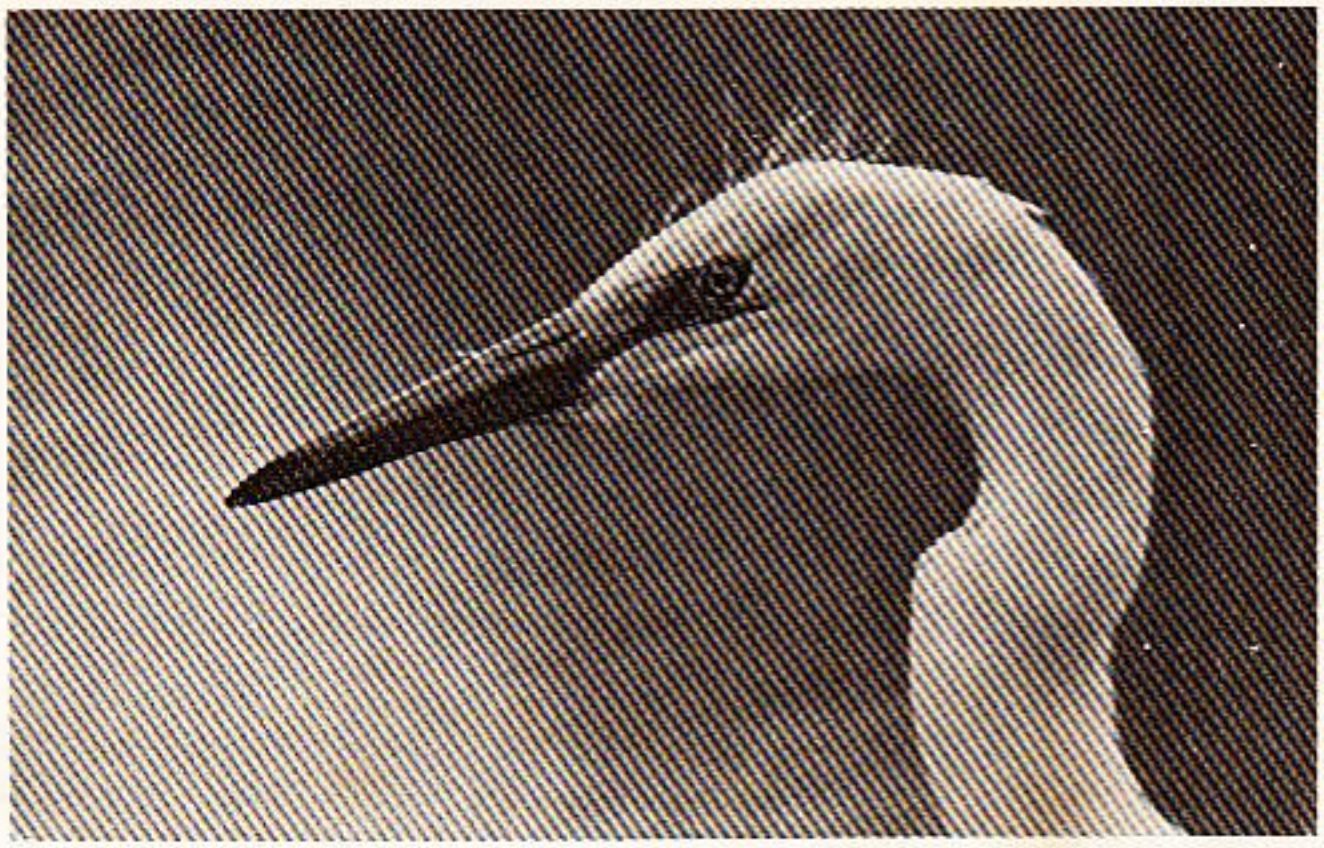
In subsequent years, too, the extermination of animals continued. Any limitations that were enforced had the interests of the landowners in mind. Thus, in 1892, a new law on hunting was passed. According to this law, the landowner was allowed to hunt on his land any animal whatsoever and at any season.

And the landowners made broad use of their rights.

By the beginning of the 20th century, forests had been depleted of animals and birds, and many species had become rare or disappeared altogether.

Russian naturalists and other forward-thinking individuals spared no effort to stop the extermination of Russian fauna. Despite the opposition of the authorities and the unbridled wilfulness of the landowners, something was accomplished. But at best these were half-measures. They postponed the extermination of many animals, but were powerless to save them.

The young Soviet Republic inherited many problems from tsarist Russia. Besides, many woods had been destroyed in the course of the First World War and the Civil War, and many animals had perished. It would seem that at a moment when the country was straining every effort in the fight for survival, its government could not be bothered with conservation. But this was not the case at all. The Bolsheviks in besieged

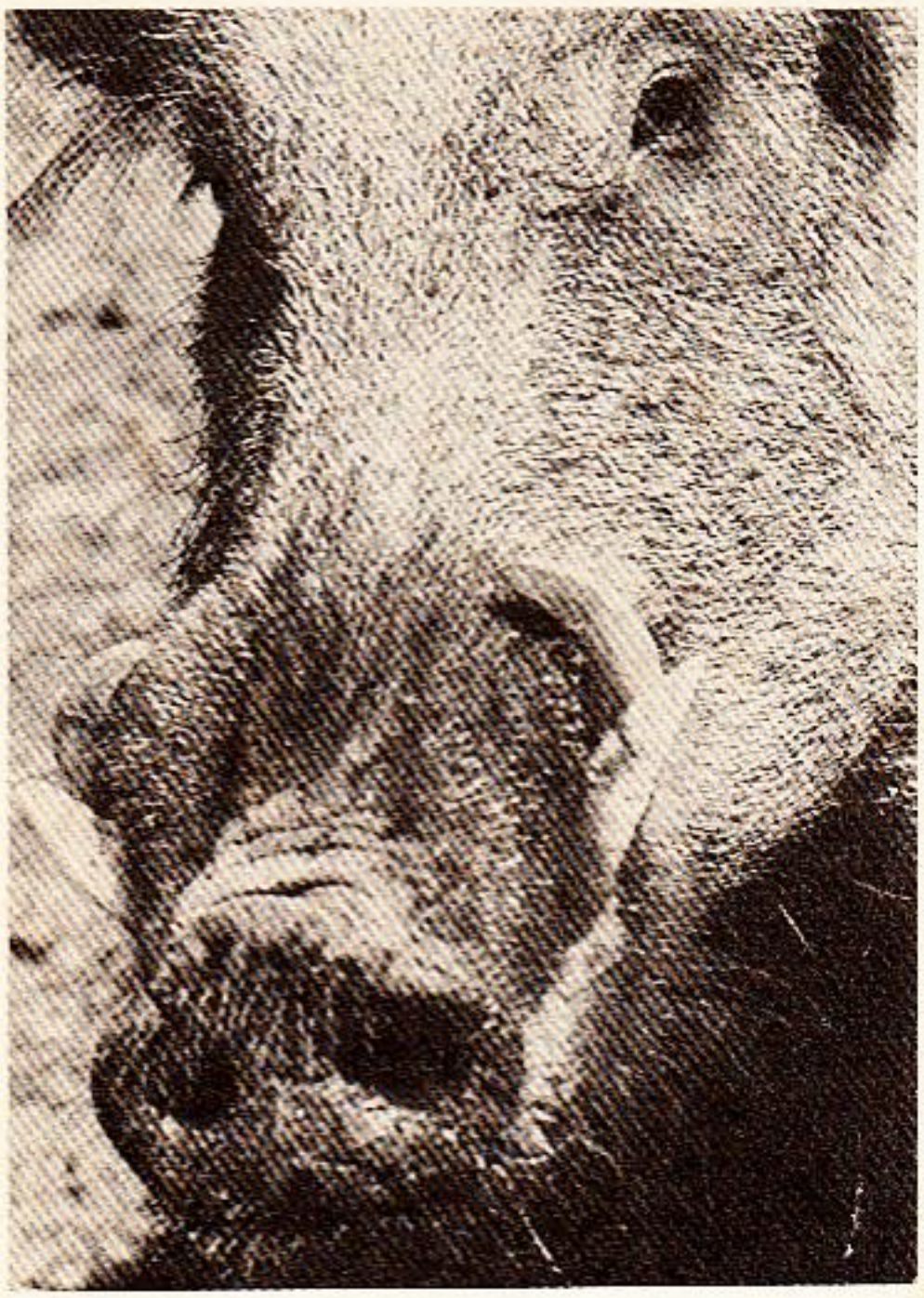


A white heron. They were killed by the million for the sake of a few feathers.

Astrakhan, who were fighting off the White Guards under the leadership of Sergei Kirov, were thinking about the future, and that included the protection of animals. Lenin in his Kremlin study was also thinking of the future — about the preservation of the country's natural wealth. That is why, on that memorable day in January 1919, he not only heard Podyapolsky out and familiarised himself with the project for a nature preserve, but also found the time to study the propositions of scientists on other aspects of nature protection. Lenin gave the plan brought by Podyapolsky his warm support and on April 11, 1919, the Astrakhan Gubernia Executive Committee passed a decision to establish a nature preserve in the Volga delta.

What Is a Nature Preserve and What Is Its Purpose?

When I first came to a nature preserve, I was terribly disappointed. Not that I had expected to see a bear under every bush, but I was sure I would see many foxes or at least a few hares. In actual fact, I did not see a single animal in the course of an entire day. True, I was luckier on other occasions and saw quite a few hares in clearings, and several times I caught a fleeting glimpse of a fox in the bushes. There were numerous squirrels hopping in the tree branches overhead. But I had counted on something far more spectacular. It was just like an ordinary forest. Of course, there were more hares and foxes to be seen there than elsewhere. When I voiced my disappointment to a man who worked at the preserve, he smiled happily. I thought he was smiling at my naiveté: didn't I understand that while wandering about the forest and lamenting its lack of wildlife, I was surrounded by a "dead zone", as it were, that all living things were giving me a wide berth, hiding in the thick grass or in the bushes, clinging to tree trunks or lying low in the foliage, that dozens of eyes watched me tensely and dozens of animals waited



The wild boar has also become a rare animal.

impatiently for me to leave so they could resume their normal lives — running about, looking for food, hunting. But it transpired that the man was smiling for a different reason. A good wildlife preserve, he explained to me, must in no way differ from an ordinary forest, at least externally.

But if a preserve differs in no way from an ordinary forest, what is its purpose? It appears that there is no concise formula.

The thing is that man exercises constant influence over nature and animals. Besides poachers who simply kill animals, the fauna is influenced by human activities which, at first glance, seem to have no direct bearing on the animal kingdom. Towns are built and expanded, land under plough increased, and roads and canals are laid. One might think that all this in no way concerns animals living, say, in a forest; it might seem that people lead their own lives and animals are free to lead theirs. People may crowd them a bit, and that is all. But the crux of the matter is that the expansion of towns, the increase in cultivated fields, and the laying of roads do not merely reduce the territories of forests.

It has been estimated that in the last few centuries, forest-grown territories on the globe have been reduced by more than half. Naturally, the number of animals living in them could not but shrink. Even if all tree felling and hunting were stopped, would that mean the influence exercised over the animal world by man had ceased? No, it would not.

If a motorway passes by a wood, naturally it influences the inhabitants of this wood, for there will be noise and petrol fumes galore. Of course, this influence is not very great and it does not affect all the dwellers of the wood. If a factory is built in the vicinity, its effect on the animals will be much greater. And there are many more factors which, in one way or another, tell on the animals.

And this occurs, mind you, even when man does not directly interfere into the life of the forest. But man cannot help interfering. And any interference on the part of man, even the most well-intentioned, may cause a change in the lives of the forest dwellers. Of course, people are aware of this. But they cannot do without timber, medicinal herbs and furs; they cannot stop building towns and laying roads. So the

The sable is a vivid example of what can be achieved if man sets his mind to the task of animal protection.

Not so long ago the elks were almost totally exterminated.

task before us is, while continuing to carry out these activities, to minimise the harm done to animals. To accomplish this, people must know about how animals live and the effect human activities have on their way of existence. They must study the behaviour of animals in the new conditions and compare it with that of those animals which have not been affected by civilisation in any way. But where are such animals to be found? Man is at work everywhere — in the desert, the taiga forests, the steppes and even in the Far North.

So people decided to set up wildlife preserves. Long before the Revolution, the forward-looking naturalists of Russia attempted to set up areas which, as Professor G. A. Kozhevnikov, an enthusiast of nature protection, put it, would be "wild nature standards", where life would go on without the least interference on the part of man. By observing the animal life in these preserves and comparing it with what happens on territories where man influences nature in one way or another, people would be able to establish what has an adverse effect on animals or plants and how these harmful influences can be eliminated or minimised.

Before the Revolution there were practically no such preserves in Russia — they were only set up when Soviet power was established. Today there are more than a hundred wildlife preserves in our country, distributed all over the Soviet Union — in the Crimea, Caucasus, Central Asia, European Russia, and even the Arctic. The preserves are not only situated in different geographical zones but often have different functions.

The preserve which disappointed me so was one of those "standard" wildlife territories where man did not interfere at all and where life in an "ordinary forest" was allowed free reign. The workers of this preserve confined their activities to preserving the forest and its dwellers in the condition which had been obtained before man's interference in nature began.

The purpose of the Kandalaksha preserve is quite different. Its aim is to protect the rare birds — the eiders that dwell there — and to enable them to breed in peace. All hunting of them is prohibited, as is collection of eggs and eiderdown. Not so long ago — a hundred and fifty years ago, to be exact — several dozen tons of eiderdown were exported from Russia annually. This down — the bird lines its nest and covers its eggs with it — only appears on the bird's body during the nesting period. It is very light, very warm and was greatly valued — one pound of eiderdown cost as much as a deer. But in order to collect a pound of eiderdown, it was necessary to rob at least 20 nests, for there is never more than 20 grams of eider in one nest. Reckon for yourself how many nests have to be robbed and the future fledgelings killed to gather several tons of eiderdown. It is no wonder that the eider soon disappeared and just a few score nests remained in the localities where many thousands were once found. It was to save the surviving birds and give them a chance to breed that the Kandalaksha preserve was set up. At the time of its establishment, there were only 58 eider nests on the islands which were included in the preserve. Today there are several thousand.

There are also other preserves whose fundamental purpose is to save rare

birds or animals and to increase their numbers. For this reason, not only hunting but catching these animals alive is strictly forbidden. Still, a person coming to the Voronezh preserve, which has become famous for saving the beaver, may very well see beavers in cages there.

How can it be that the catching of rare animals is forbidden, yet...

There also exists a kind of preserve where rare animals are caught for resettling. The Voronezh preserve is one of those. But let us discuss beavers in greater detail.

People have evidently known beavers since very long ago: archaeologists find beaver bones beside stone knives, and necklaces portraying this animal have been found in Bronze Age strata. Beaver hunting became more intensive when people realised that in addition to tasty meat, the beaver also had an unusually warm and strong coat. Later still, beavers were prized for so-called "beaver spray" — the musk secretion of a special gland to which remarkable healing properties were ascribed. "Beaver spray" was valued much more highly than beaver pelts, which, for their part, were enormously costly.

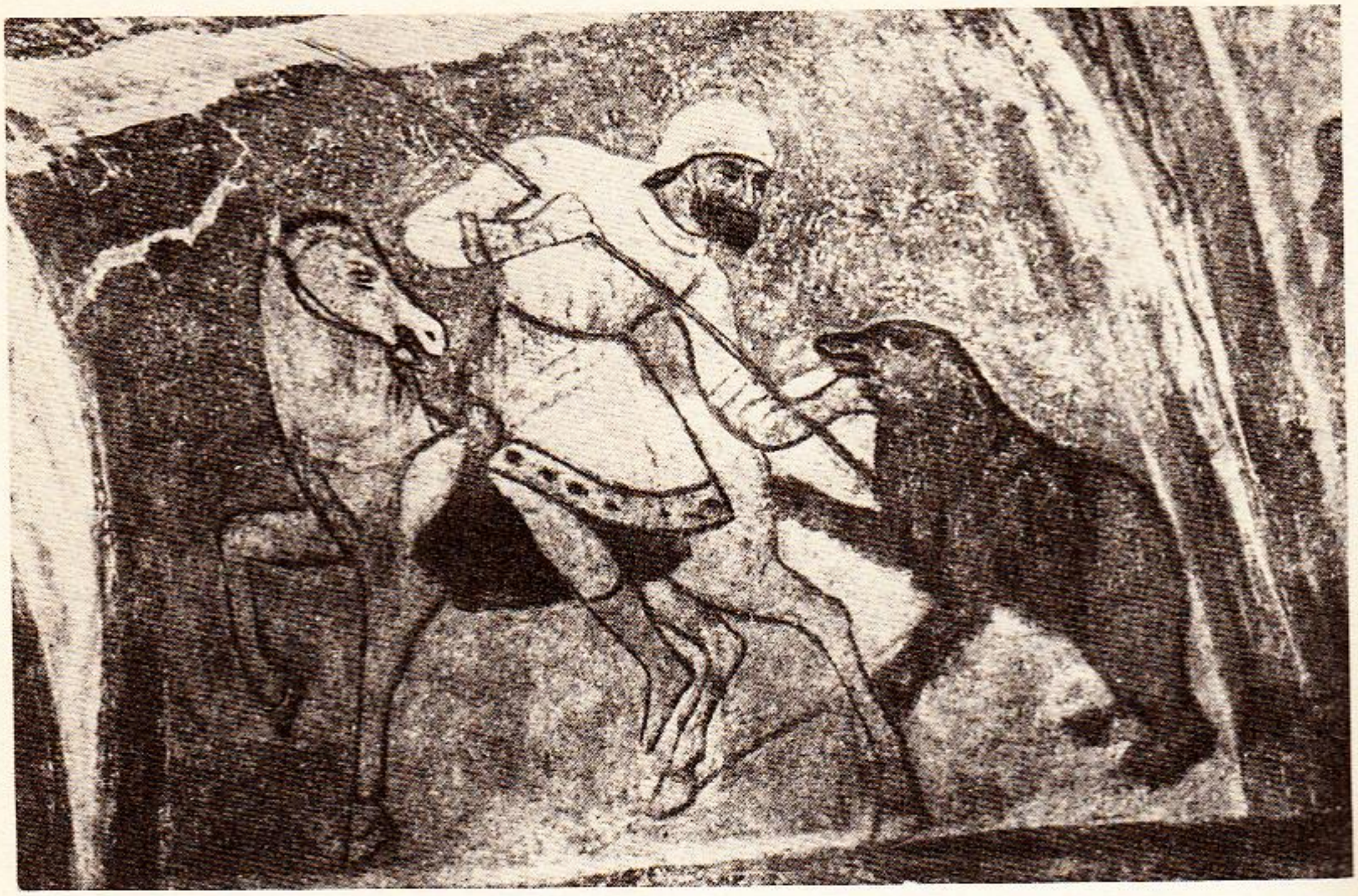
A beaver is an easy animal to hunt. They settle in definite localities on the water, and it is easy to find their settlements by their characteristic dams and huts, as well as by the stumps of trees felled by beavers. True, it is almost impossible to catch a beaver in the water, for it is very agile in this element, and its hut is strong and has an underwater outlet. But on dry land, the beaver is defenceless, and this was where hunters lay in wait for it.

It would seem that these animals should have been wiped off the face of the earth long ago. But one must surmise that in olden times people were more solicitous towards animals than their descendants. Even in primitive society, people did not hunt beavers as they did in later epochs, but set up beaver farms. This means that upon finding a beaver colony, people did not kill every animal to the last but only the males — the killing of a female was considered a crime. Often, people even settled beside a river inhabited by beavers, for this animal provided them with both meat and skins. So the number of beavers did not decrease, and the animal continued to flourish both in Europe and America. Back in 15th-century Russia, there existed two kinds of beaver grounds — "beaver hunts" where beavers were hunted, and "beaver farms".

When private ownership of land evolved beaver settlements became the property of landowners and were also strictly guarded.

But the last two or three centuries proved fatal for beavers. The wooded areas had shrunk. The huge sums of money paid for beaver pelts and "beaver spray" brought about the almost total extermination of these animals in Europe, Asia and America, where there were also numerous beaver colonies. About a hundred years ago, beavers practically disappeared in Europe; poachers were hunting down the last animals, which had found refuge in the depth of pristine forests on small rivers, and, finding a settlement, killed every single animal. The beaver population in America had shrunk as well. Poachers were not daunted by the strictest of laws (and such laws had been passed), the risk they ran being well worth the money they received for pelts.

As a result of it all, no more than



A bear hunt. A 9th-century fresco in the St. Sophia Cathedral in Kiev.

from 700 to 900 beavers remained in Russia by 1917. They lived in small colonies in 15 localities. One such colony was on the bank of the River Ivnitsa not far from the city of Voronezh. And here, in 1922, a beaver preserve was founded.

At that time, the beaver population of the Ivnitsa numbered some 30-40 animals. A mere five years later, it had grown to 100-120. After another few years had passed, the preserve had enough beavers to permit their being caught for the purpose of resettlement.

Thus it was that new settlers came to quiet forest streams in many regions of the country. Actually, they were not really new for these lands, since beavers once lived on the small rivers of Moscow Region, on Lake Baikal and in the North, and now, with man's help, they have come back to reclaim their old domain.

People who organised the resettlement of beavers chose the best and most convenient sites for them — remote, quiet and with plenty of food. The rest was up to the beavers themselves. Indeed, after investigating their new area, the beavers set about building strong huts with entrances concealed underwater. The beavers have their own way of achieving this aim — after building a hut, they build a dam, raising the river level so that water overflows the entrance. The beavers don't

mind diving to get home — they are excellent swimmers and water is their element.

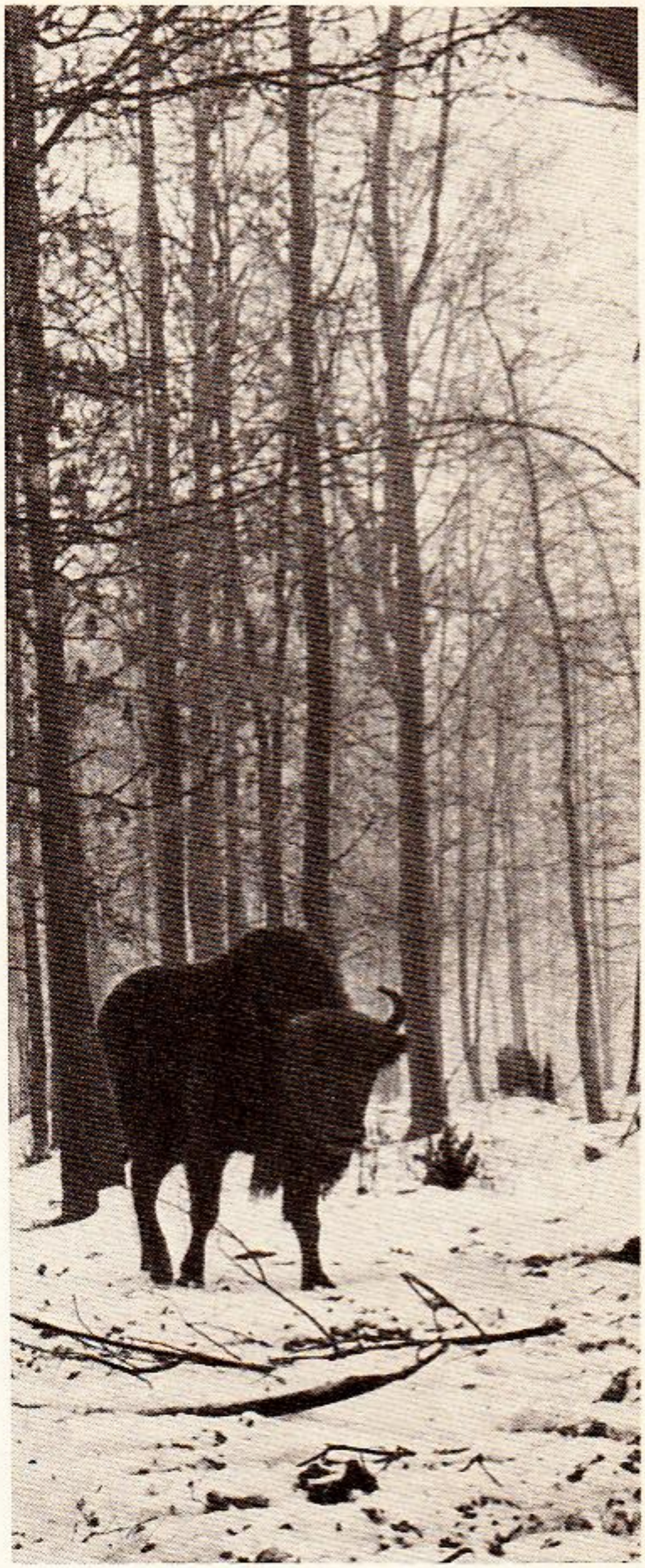
Beavers are strong, cautious animals, and their huts are quite reliable. Still beavers, and especially their cubs, have quite a few enemies — birds of prey, big pikes and sheat-fish.

Beaver cubs are exposed to particular danger during the spring floods, when they have to leave the huts and seek refuge on islets of dry land or floating logs. They have not yet learnt to dive and fall easy prey to predators. So men, in resettling beavers, keep an eye on them and come to their aid when necessary.

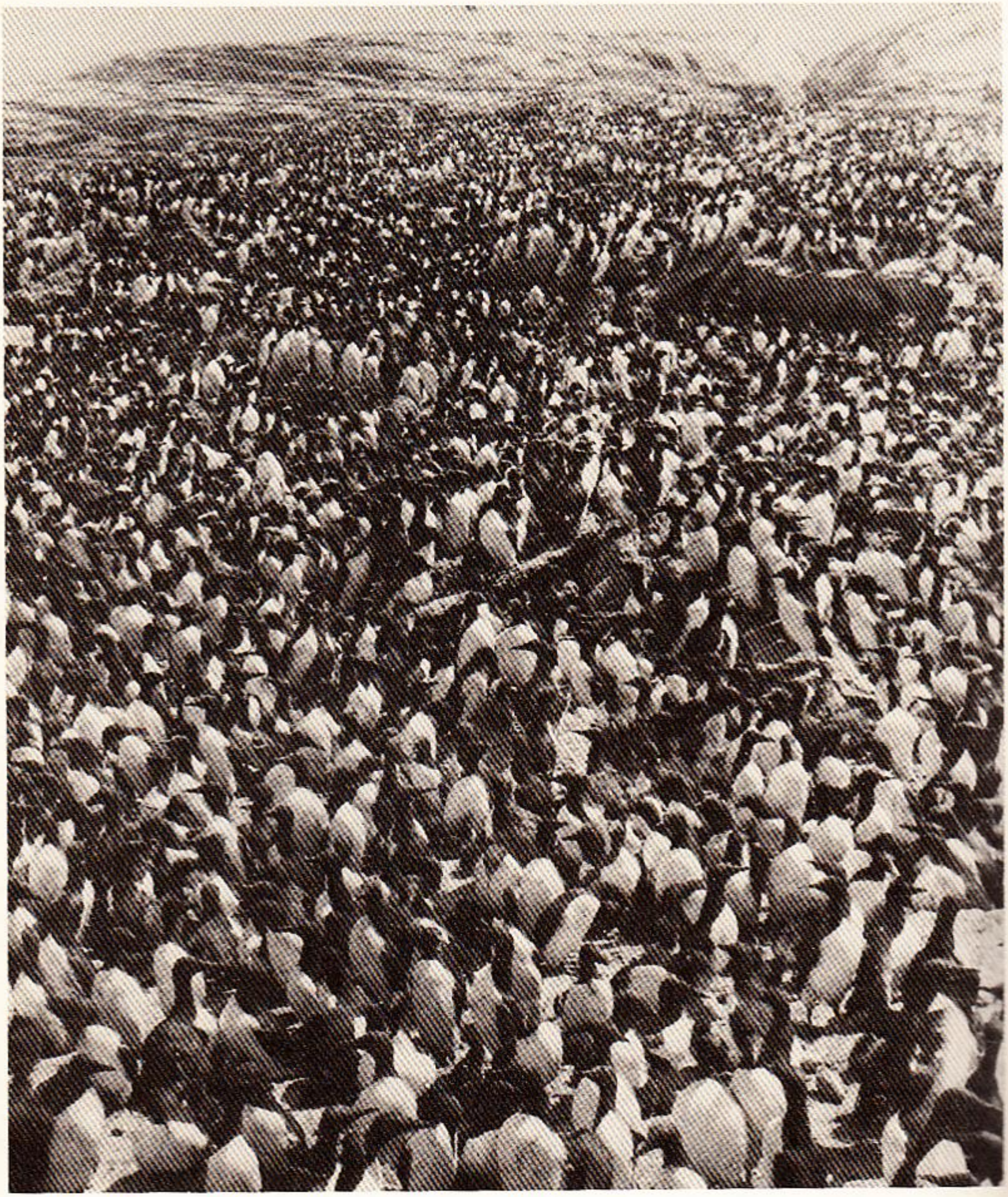
Today there are thousands of beavers living in our country. Not all of them have been reared in preserves, but all have survived thanks to man's efforts.

A very similar fate befell another precious fur-bearing animal, the sable. At one time it, too, was widespread not only in Siberia but also in European forests and reached as far west as today's Byelorussia and Lithuania. There were many sables in Muscovy. Huge numbers of pelts were exported from Siberia and other parts of Russia. But with each year, there were fewer sables, and pelts became dearer. And the dearer the pelt, the more the sable was sought after by hunters. Its numbers began to decrease at a disastrous rate. Between 1896 and 1900, 44,280 sable pelts were sold at the Irbit fair, the fur fair in pre-revolutionary Russia; in the next five years the respective number was 31,440. And between 1906 and 1910, only 14,400 pelts were sold.

In European Russia, the sable had been exterminated completely, and there were insignificant numbers left in Siberia. For instance, in the Bar-



The European bison, the mammoth's contemporary, has practically been revived from the dead.



There are so many birds here one imagines they are in no danger of extermination, but this is an illusion.

guzin Range district, where a preserve was set up in later years, no more than 20 sables lived at the time it was established. About the same number survived in Kondo-Sosvinsky district, which, back in the 17th century, supplied up to 2,000 sable pelts to Moscow annually.

Like the beaver, the sable was threatened with complete extinction. And this would have certainly come to pass had not preserves in those localities where the sable was still to be found been established and all hunting of this animal prohibited. As the result, the few surviving animals bred and multiplied until the sable once again could be hunted for pelts and also resettled to other areas. Between 1927 and 1957, 12,500 sables were resettled.

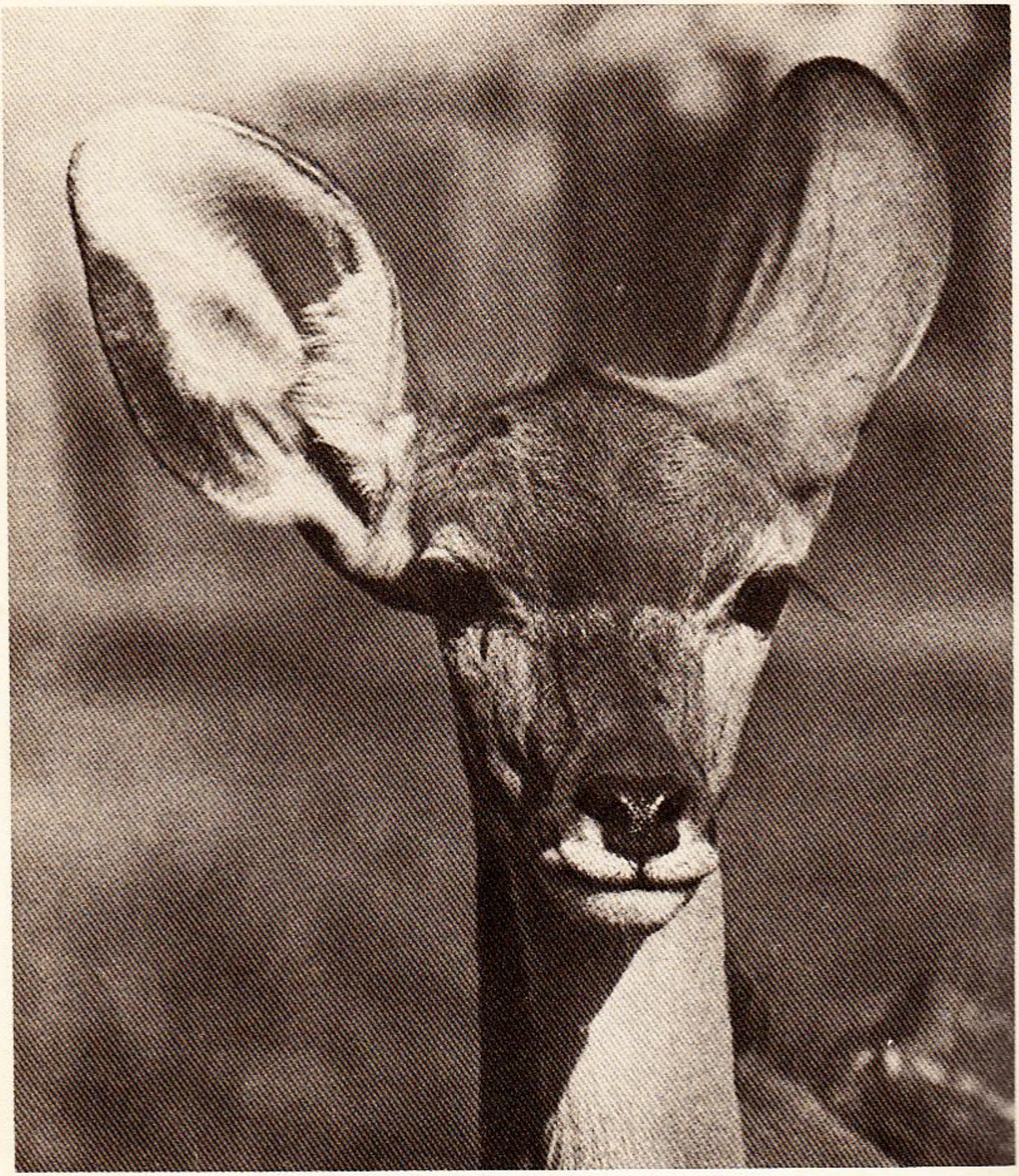
The beaver and the sable are but two examples of what man can accomplish if he sets his mind to it. There are other instances of resettlement of rare animals — for example, wild goats from the Caucasian preserve and even rarer chigetai from the Badzykh preserve in Turkmenia.

The "Duck" Flies to Africa

We know that many birds winter in Africa. Ducks also fly off to warmer climes in autumn. But the "Duck" which flew to Africa in 1957 was a special kind — it was an airplane. A very small airplane, painted *à la* zebra, in black and white stripes. The plane was piloted by two brave men, Professor Bernhard Grzimek and his son Michael.

The Grzimeks named their plane "Duck" because all planes of that type were given four-letter names, so why not "Duck"? They were going to fly ten thousand kilometres over sea and land, cross many state borders, and pass over mountains and deserts. And this, mind you, was merely the beginning of the journey to their destination. Their destination was the huge Serengeti wildlife preserve in Africa. They were going there to ... count animals. Laymen have no idea what an important aspect of conservation the stock-taking of animals is. They may think that the more animals there are in a preserve, the better — is not that the guiding idea? To be sure, the more animals there are, the better it is. But only within certain limits. The point is that man creates such favourable conditions for animals in wildlife preserves, protecting them from disease, poachers and sometimes even predators, that they breed readily and soon exceed the ratio established in nature. They become too "cramped", and a shortage of food makes itself felt. The rate of propagation achieved in favourable conditions can be judged from the following example.

At the end of the last century, several deer were brought to a menagerie. They soon escaped and started living in the forest, the same where the Voronezh preserve was subsequently set up. By the time the preserve was established, there were not too many deer in existence — just several animals; the hunters and wolves had been keeping their numbers low. But when the deer found themselves protected from all dangers, they started to breed at such a rate that 30 years later, there were nearly 800 deer in the preserve. And another ten or twelve years later, there were more than a thousand. There would have been even more, if people had not kept their numbers down artificially, knowing that too great a growth of the herd might cause starvation and



We must do everything in our power to assure that these and many other animals continue to live on Earth.

epidemics. So a certain proportion were caught and resettled. Today more than 1,500 deer who were born in the Voronezh preserve live in other regions of our country.

Thanks to man's protection, the deer were able to multiply, but if they had not been counted and their numbers reduced, a tragedy might have occurred, as it did with the black-tailed deer in Arizona, USA.

Indiscriminate hunting caused a dwindling in the black-tailed deer population until, in 1906, no more than four thousand were left. Then all hunting was strictly forbidden, and the deer began to multiply quickly. Twenty years later, in 1925, there were a hundred thousand. People rejoiced, having no suspicion of the impending tragedy. The very next year, in 1926, the deer began to die in vast numbers. Five years later, only 20 thousand remained of the herd of a hundred thousand, and by 1940, the number dropped to 10 thousand. The deer had begun to die of undernourishment, which, in its turn, caused a number of diseases.

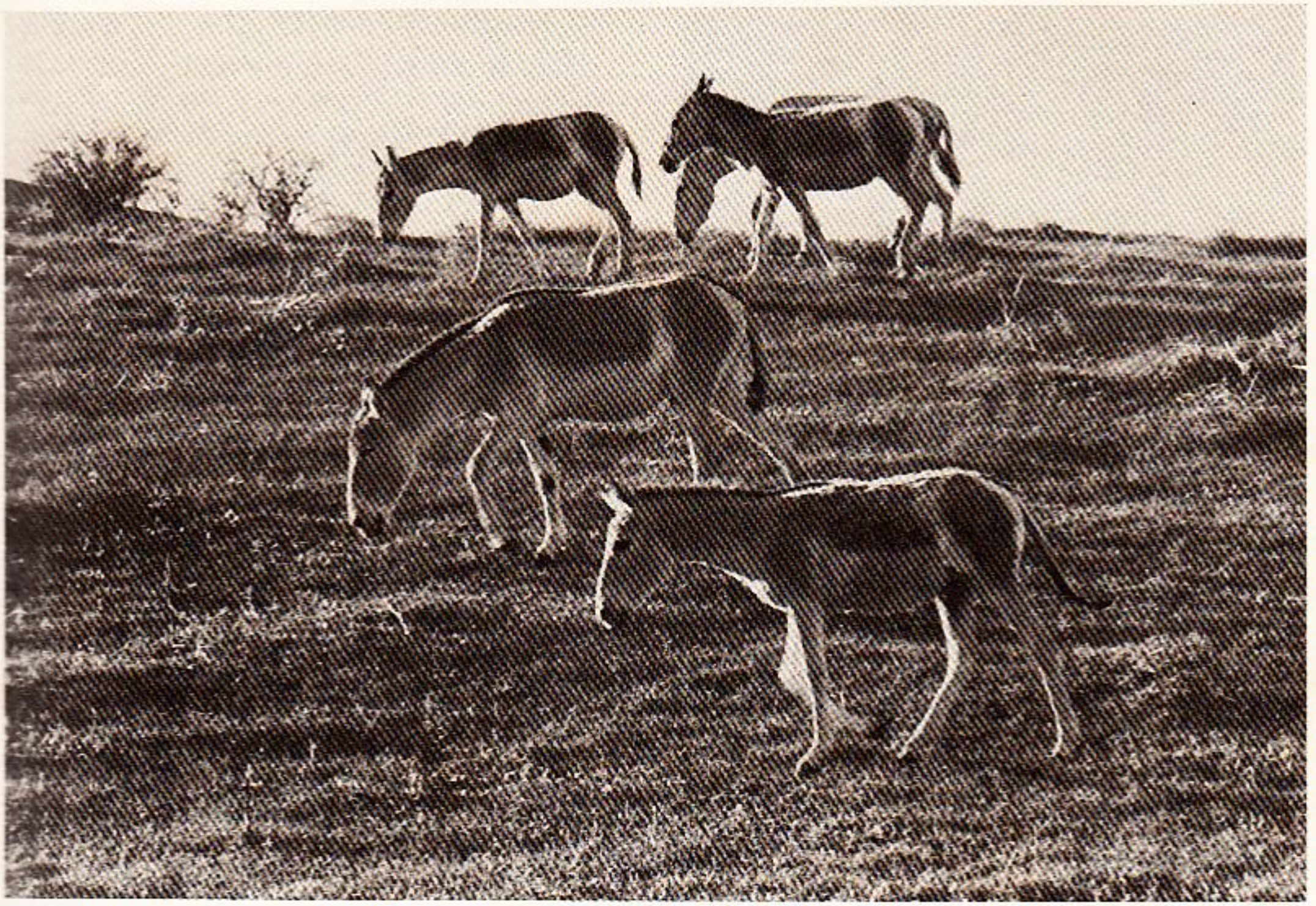
In natural conditions, the animal population is regulated by the availability of food, the number of predators, etc. If man protects animals and creates exclusive conditions for them, he must learn to count them.

On the whole, a stock-taking of animals is very necessary. Without it, we would not know how many animals are left, which have become rare, and which are disappearing altogether. And, conversely, we must know the number of quadrupeds and birds to preclude excessive "cramping", which leads to mass death.

But this is easier said than done. How is one to count deer, or elk, or bears, or foxes? And how is one to

This is how they depicted beavers in the old times.

And this is what a beaver really is like.



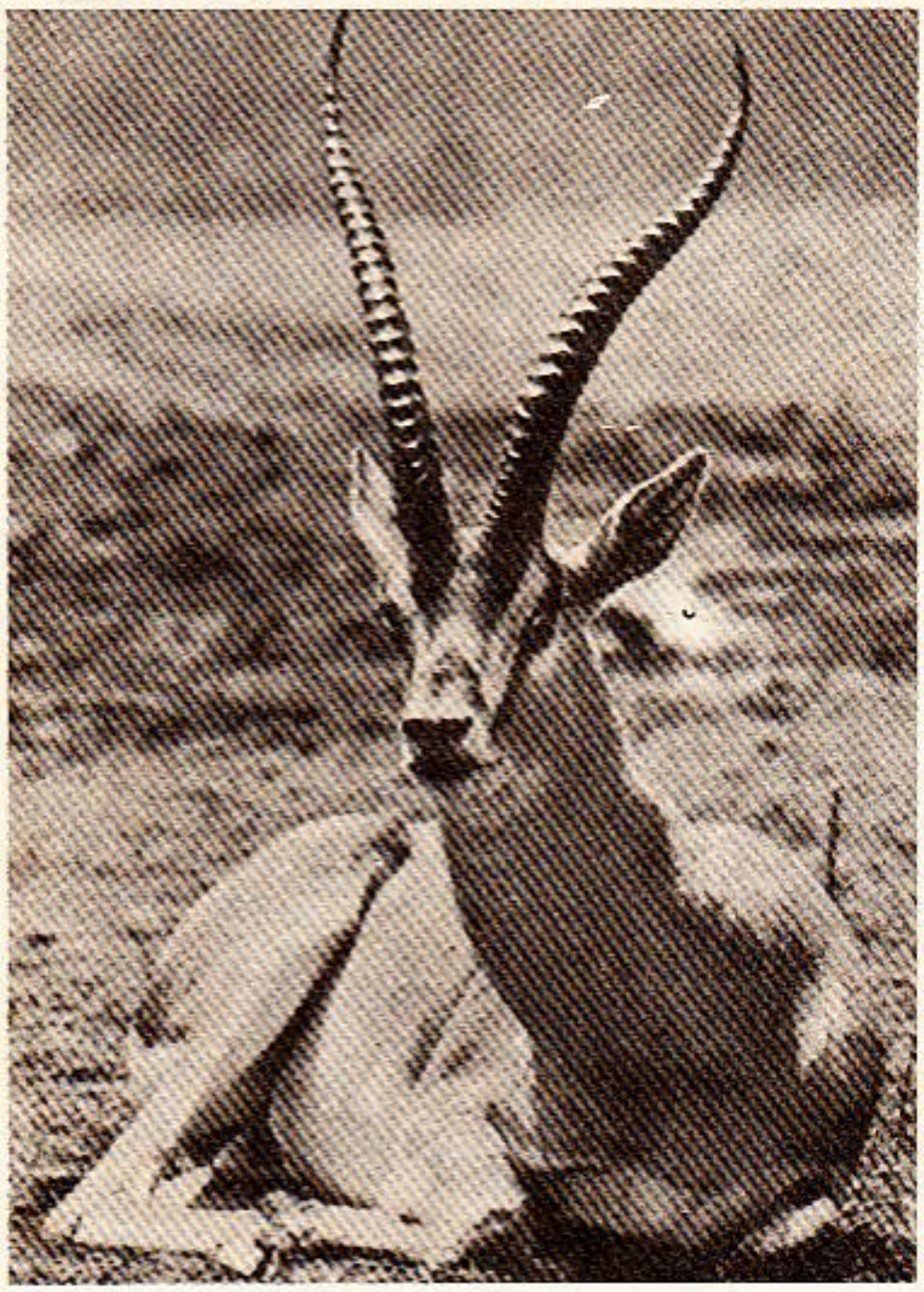
Chigetais (Equus hemionus) have only survived in nature preserves.

count moles which are never seen by man?

Zoologists have thought up many methods of counting animals. Some animals, such as beavers, musk-rats and badgers, which have permanent huts or burrows, are fairly easy to count — all one has to do is to find their burrows, to establish which of them have dwellers and which have been abandoned, and to find out how many animals live in the inhabited ones. All that remains is to add up the figures obtained.

It is both easier and more difficult to count wolves and foxes. It is more difficult because these animals only have temporary lairs for the period when they bring up their young; therefore, the search must be made in early summer. It is easier because the lairs are easily found and there is no doubt as to whether they are inhabited or not.

But there are many animals which have no homes at all. Therefore, they are counted in winter, by their tracks in the snow. This is not a straightforward task either, for one hare or elk may leave so many tracks it might seem a whole herd passed by. Zoologists have developed the following method: they mark a testing territory and obliterate all tracks on its borders. Then, special beaters moving in a line drive all the



An antelope. What would have been the fate of these animals had not the "Duck" taken off for Africa one day?

animals out of the territory. All of them are sure to cross the border where the tracks have been obliterated and leave fresh ones, which can then be counted.

Naturally both permanent and temporary dwellings are not sought out over the entire territory of the forest, but only within a certain area. If, say, one hundredth of the entire forest territory is taken, then the figure obtained has to be multiplied by one hundred.

There are many other methods. The latest achievements of science and technology have been drawn upon to help zoologists. Aerial photographs of a territory may be taken. The photographs are then enlarged, and the animals in it counted. Also, some animals are marked with indelible paint, ringed or collared, and sometimes a tiny radio transmitter is fitted into the collar to provide information about the animal's whereabouts.

But these and other methods of counting animals were not suitable for the Grzimeks, because they had the unique task of counting animals on a territory of 12 thousand square kilometres.

This was the territory of the national park in Tanganyika, now the sovereign African state of Tanzania. But at that time, in 1957, Tanganyika was still a mandate territory, and the British government was not unduly concerned about the fate of rare wild animals, for otherwise, it wouldn't have conceived a plan for reducing the territory of the park. This reduction by a third of one of the few remaining African preserves where herds of wild animals were still able to roam at large in freedom and security was not a matter of mechanical curtailment of area. It involved a threat to the lives of many animals. This was clearly understood by both Professor Bernhard Grzimek, who had devoted his whole life to animals, and Michael, a young but already experienced zoologist, who was as passionately fond of animals as his father and as fervently dedicated to the cause of their protection.

But how were they to prove the perniciousness of this project — how could they demonstrate that it would entail a catastrophe?

Professor Grzimek had on several occasions visited Africa, including Serengeti. He knew that herds of antelopes, zebras and giraffes migrated

over large territories. Why was that? What made them move from one place to another? How far did they travel, and would they leave the confines of the preserve if their territory were curtailed?

Eventually Michael Grzimek would collect samples of souls and grasses from different parts of the Serengeti park. This would help zoologists to establish that the migrations of animals were not haphazard, that they found food in different zones at different seasons, and many of these zones lay far beyond the proposed new borders of the preserve. This meant that with the reduction of the preserve's territory, a large proportion of the animals would lose the protection provided by the park and fall prey to poachers.

Professor Grzimek would be able to prove conclusively that to curtail the area of the preserve would be a fa-

These striped horses have no idea what danger threatens them.

How much effort it cost the Grzimeks to save these animals!

tal error. But that would happen later. For the time being, the two of them were on their way to Africa to count the animals so as to be in a position to face the British authorities with facts and figures.

To accomplish this mammoth task, they needed money, and the British administration of Tanganyika had announced that it had no funds available for counting lions, zebras, giraffes and gnus. The Grzimeks could not afford to shoulder the expense involved. But any delay was fraught with disaster, for the decision on the reduction of the preserve's area had already been taken. At this point the Grzimeks had a stroke of luck. A film which Michael had made at his own risk and expense, which necessitated his going into debt, which had been rejected by West German cinema owners because the ani-

mals in it were too peaceful and did not attack or kill anyone, was unexpectedly awarded the first prize at film festival. It was bought at once by cinema owners in several countries, and the Grzimeks suddenly received a considerable sum of money. Of course, they could have found many other uses for it, but father and son did not hesitate to spend it all on saving the African animals.

So they bought a small airplane, enrolled in flying school, and as soon as they graduated, started on their long and hazardous flight to Africa.

Before the Grzimeks started on their venture, it was believed that more than a million different animals lived in Serengeti. The Grzimeks began counting the animals from the air. It was a formidable job, for it entailed repeated flights over the same area so that all animals could be accounted for — and don't forget that animals do not remain static in the meantime. Besides, the airplane did not have any silencers on its engines, and its roar was truly head-splitting. Still the Grzimeks continued with the task in hand. And the longer they worked, the clearer it became that there were far fewer animals in Serengeti than had been believed. The figure they finally arrived at was just one third of the conjectured million — 367,000.

This was the first result of the Grzimeks' work, and the low animal count made it amply clear that the territory of the preserve could under no circumstances be reduced; if animals suffered so much from poachers while under protection, they would be doomed if they got outside the confines of the preserve.

It still remained to be proved that the animals would in fact cross the borders of the preserve. So father and son changed to a car. Their task now was to catch animals and mark them somehow. Michael Grzimek had invented a special gun which shot bullets with a narcotic. These bullets did no harm to the animals, which awoke after the sleep induced by the narcotic and walked off without even noticing they

Michael Grzimek.

were now wearing strong, light collars that were brightly coloured and visible from afar.

The gnus and gazelles could be brought down by the wonder-gun, but the alert zebras did not allow the zoologists to get within shooting range. They had to catch up with them in their car and grab them by the tail, which was not only difficult but also dangerous, for the hairs on the zebra's tail are sharp as a razor blade.

All the same, soon hundreds of zebras were sporting brightly coloured collars. Now the Grzimeks could watch their movements from the airplane.

Meantime, Michael set about studying the soil and the grasses.

The final conclusion was: if valuable animals were to be preserved, the size of the park must on no account be reduced. Professor Grzimek offered such weighty proof that the British authorities were forced to revoke their decision.

Since then the British have left Tanganyika. The new government of Tanzania is doing its best to preserve Serengeti and its residents — for the people living today and for those who will come here in twenty or a hundred years to see the striped horses which have been saved from extinction, the amazing giraffes and the noble lions.

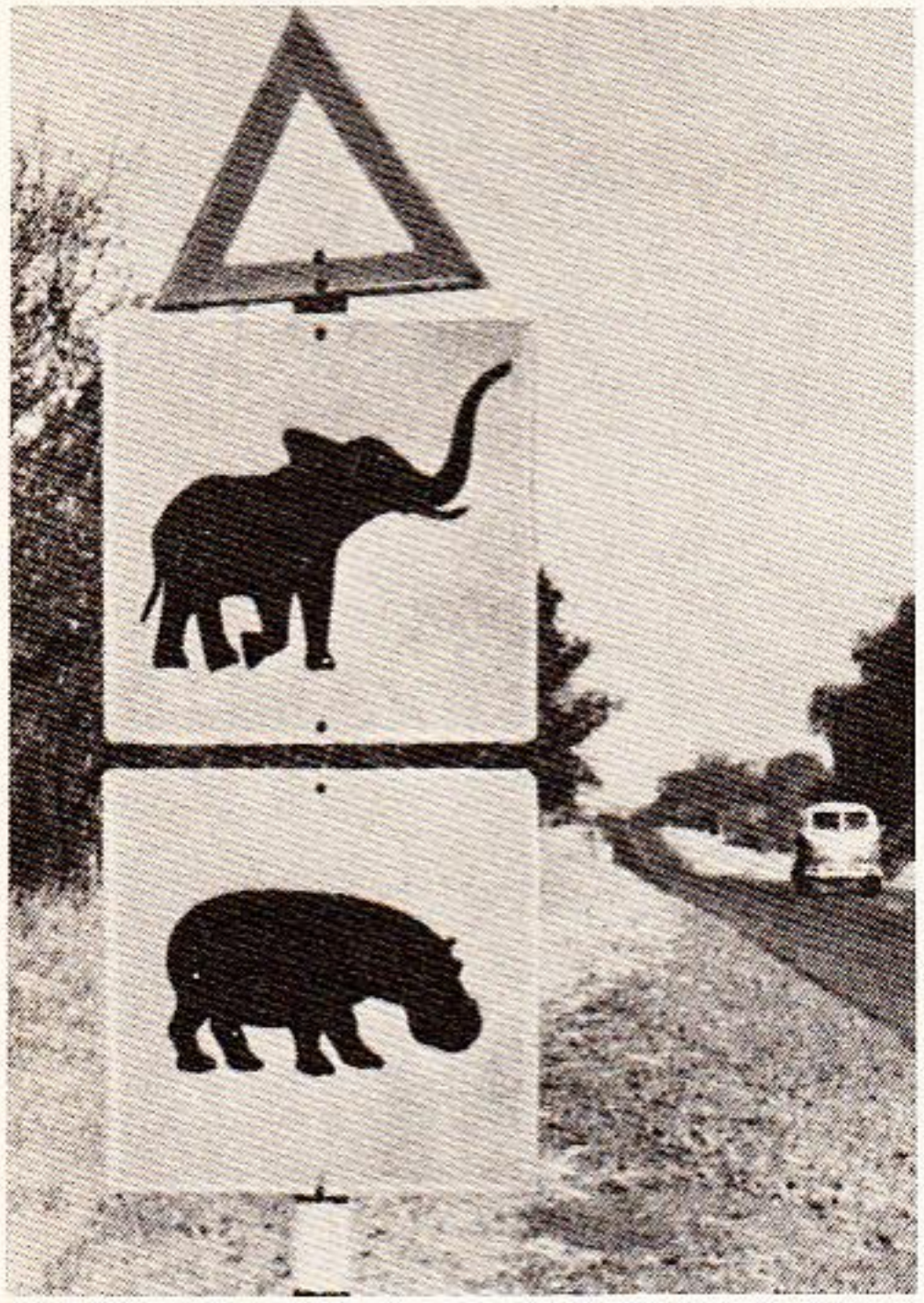
Many of the future visitors of this unique preserve are sure to stop by the memorial on which is engraved:

MICHAEL GRZIMEK

12.4.1934-10.1.1959

He gave all that he possessed,
his life itself, to preserve the
wildlife of Africa.

The spotted deer have not only been preserved by man but he even re-settles them.



Such road signs are also necessary in places today.

Michael died in an air crash involving the very same "Duck" on which he had flown to Africa two years previously. He is buried on a green mound in the very centre of the preserve which (who knows?) might have ceased to exist by now if the "Duck" had not started out on its long flight to Africa on the gloomy morning in December 1957.

Perhaps a Zoo as Well?

Perhaps he is right, this warm-hearted, wise and brave man?

He has loved animals ever since he can remember and at an age when the other boys were dreaming of becoming engine-drivers or firemen, he dreamed of a zoo of his own where he could come every day, or, better still, which he would never have to leave and where he could be with animals twenty-four hours a day.

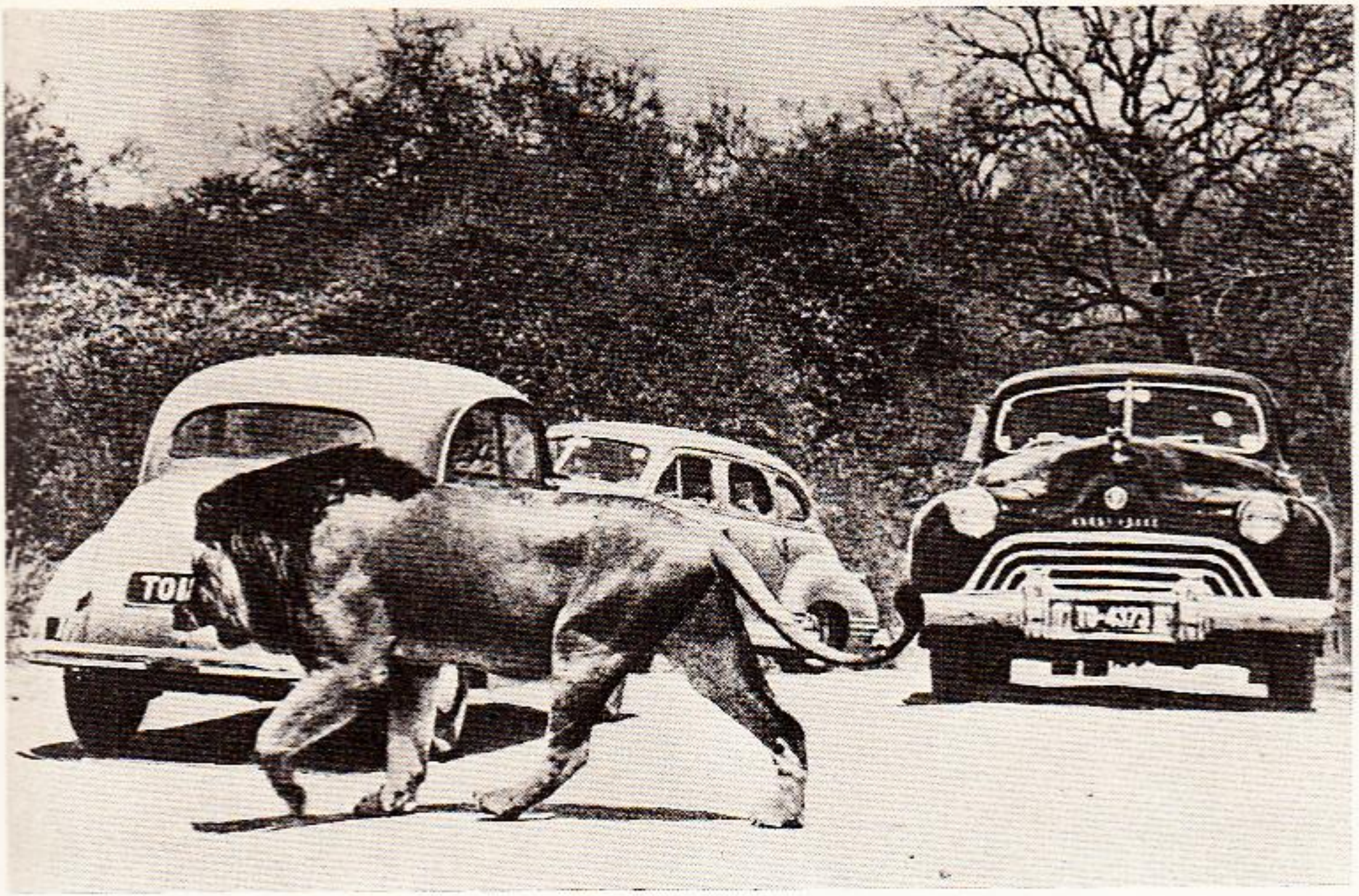
Years went by, and many things changed. Little Jerry became Gerald Durrell, but his love for animals, far from abating, grew stronger by the day.

Gerald Durrell became a traveller, a prominent naturalist and a famous writer. He has written many wonderful books about his travels and adventures, about the people he has met on various continents, and, above all, about the animals he has brought back from his trips.

But still he dreamed about a zoo of his own. Only it was an adult dream now. Little Jerry simply wanted always to be with animals, to observe them and to take care of them.

It was not just that the adult Gerald Durrell was pained to part with the animals he had brought from his travels and had grown attached to. During his worldwide journeys, he became aware that many animals were in danger of extinction, and his heart ached for them. They had to be saved at all costs, and here his dream of a zoo of his own came in. But he wanted to set up a special kind of zoo.

People come to a zoo to see various beasts and birds. They rarely stop to wonder whether the purpose of a zoo is merely the demonstration of animals. In fact, most private zoos and menageries existed solely for the entertainment of the public and the enrichment of the owner. But there were and are other kinds of zoos, where serious zoologists conduct obser-



Lions, too, had better learn the traffic rules.

vations and experiments and make important discoveries. And only very few people know that it was thanks to these zoos that quite a few animals have been saved from total extinction.

Visitors to the Moscow Zoo have undoubtedly noticed a remarkable animal with a small mane and sad eyes. This animal has several names, and the Chinese one means "one that is unlike any of the four": the animal has a deer's antlers, but it is not like a deer; it has a cow's tail, but it is not like a cow; it has a goat's hooves, but it is not otherwise like a goat; nor it is like a horse though it has a mane. In fact, it is indeed unlike any of the four. The Europeans call the animal "milu" or Father David's deer. It was named in honour of the missionary Armand David, a traveller and explorer of Asia, the first European to see this animal and report the fact to zoologists.

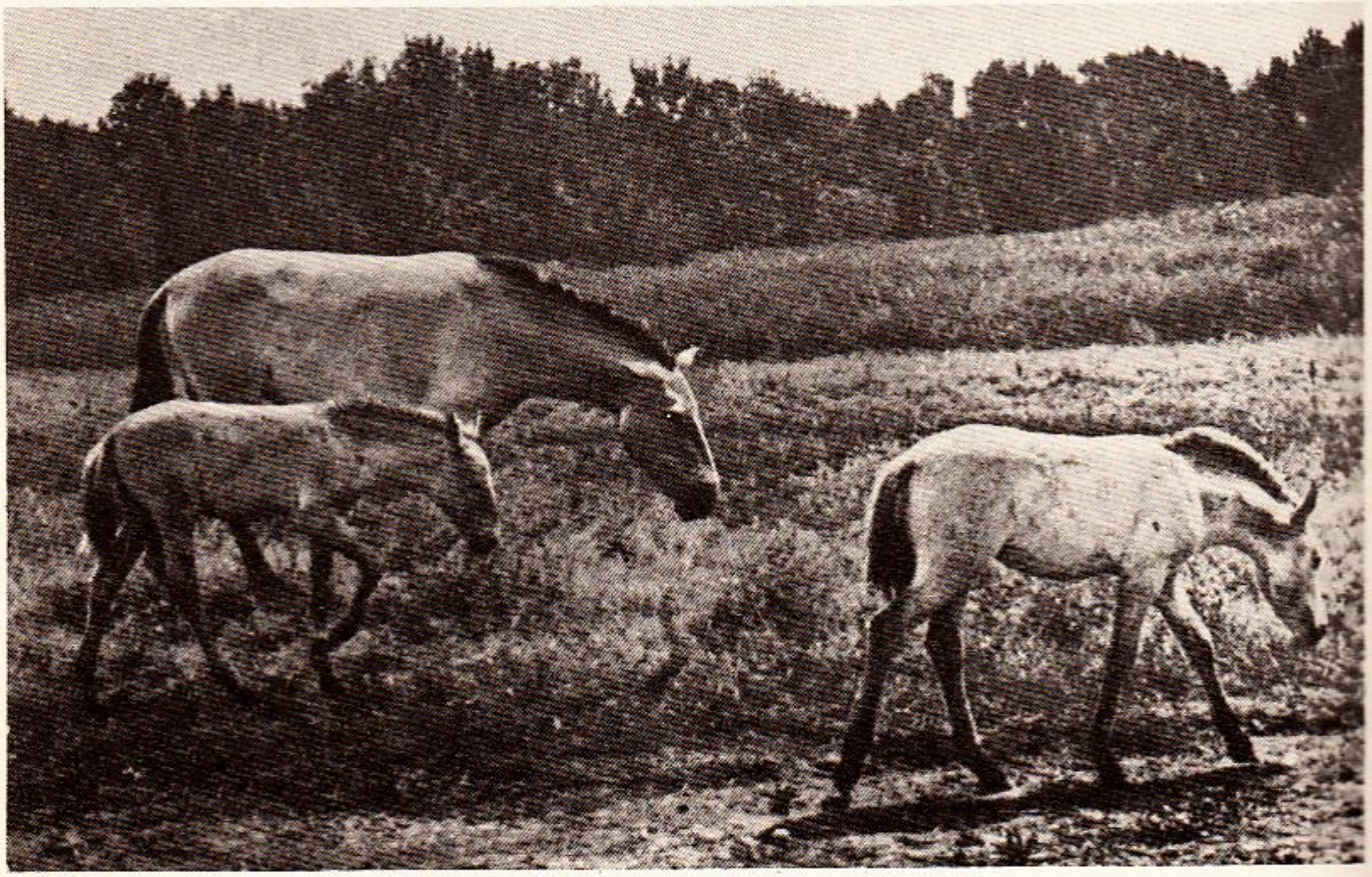
By that time, this deer was not living anywhere in a free state; the only herd in existence, numbering 120 heads, grazed in the garden of the Chinese Emperor behind a tall wall. They were considered sacred animals, but, a true naturalist, undaunted by the penalties entailed, Father David climbed the wall to have a good look at the odd creatures.

His venture had important consequences; once the secret of the milu was revealed, several of the animals

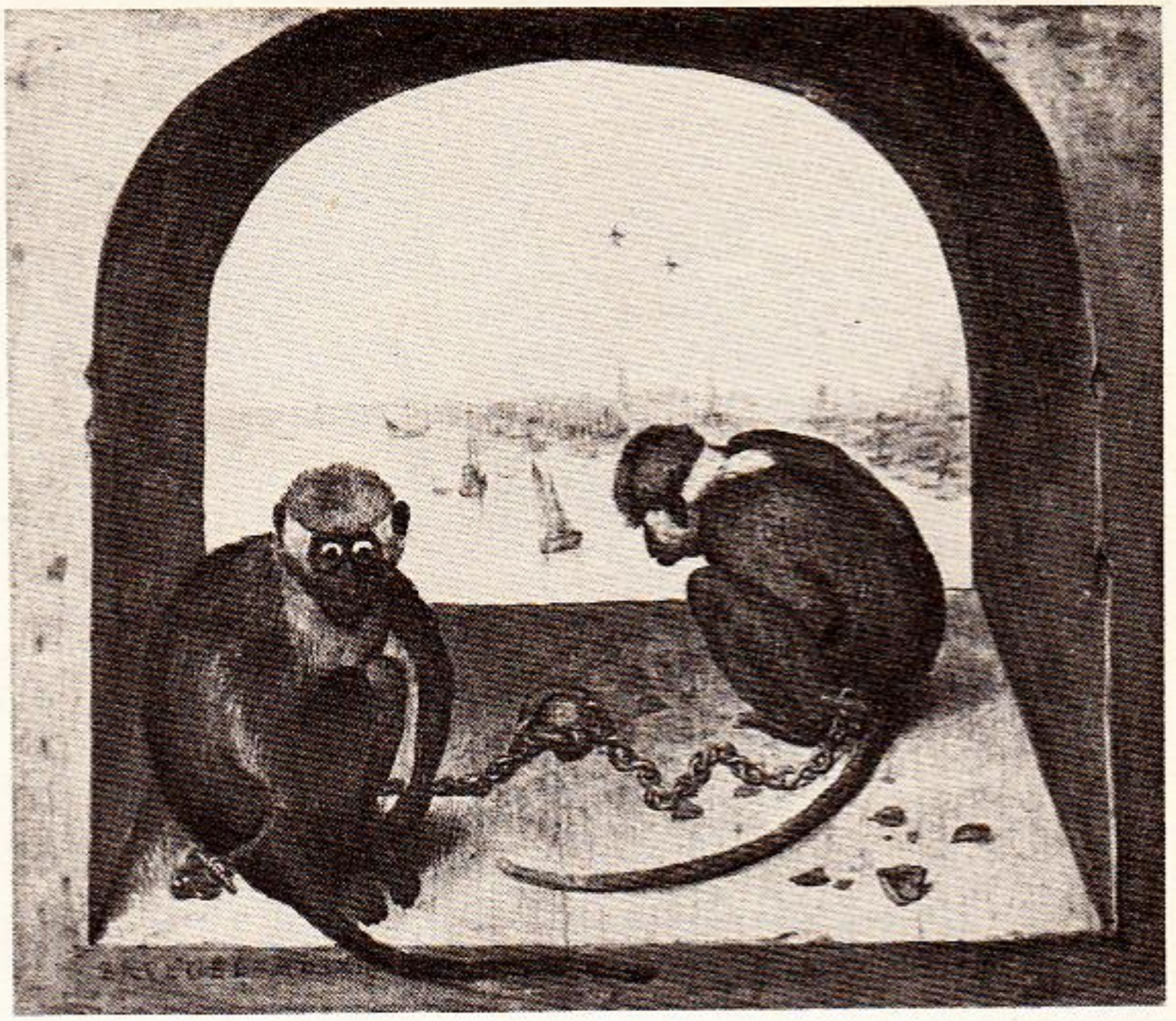
The great emerald bird. In Wallace's time these birds were very numerous. But before long they were almost completely destroyed to adorn ladies' hats.

found their way to Europe. Twenty years after Armand David discovered those deer for the science of zoology, the Huang He River flooded, swept away the wall of the Emperor's garden, and the deer scattered about the environs. Soon almost all of them were killed, and the remainder of the herd was destroyed during the Boxer Rebellion. The last milu in China was killed in 1900.

So the milu would not have lived to see the 20th century but for the several animals that had been brought to Europe. Before long, the graceful animal which was unlike the deer, the cow, the goat and the horse was to be seen in many European zoos. It thrived in captivity.



The Prjewalski's horse, the only wild ancestor of the domestic horse which still lives on Earth. There are no more than 200 such animals left and they were all born and grew up in zoos.



Monkeys did not live long in captivity. They died of diseases and homesickness. The Dutch painter of the 16th century Pieter Bruegel the Elder portrayed such a pining pair in his picture "Two Monkeys".

Undoubtedly Gerald Durrell knew the story of Father David's deer that had been saved by the zoos. And he also knew the story of Prjewalski horse.

The famous Russian traveller Nikolai Prjewalski brought the skin and skull of an unknown animal from his travels in Central Asia. In 1881, the zoologist I. S. Polyakov described this animal and established that it was the forebear of our domestic horses. The animal was named Prjewalski horse in honour of its discoverer. A quarter of a century later, only a small herd of these horses survived in Central Asia. But several animals were living in the zoos. By 1965, the number of Prjewalski horses in the zoos reached 125. Successful breeding of these animals in captivity encouraged the zoologists: the species, they decided, could be restored. In 1959, an International Symposium decided to set up an international society for the preservation of the Prjewalski horse. Six years later, at the Second International Symposium, the zoologists reported successes achieved in this venture.

Durrell could not but know about these instances, as well as many others, such as the saving of the Hawaiian goose, of which we now have 500, while in 1950 no more than 40 birds were left on Earth. Then there was the Persian fallow-deer and many other animals which became extinct in the wild for various reasons and are to be found only in zoos.

There was also the saving of the bird of paradise: when, in the early 20th century, the bird of paradise,

Animals thrive when their keepers are fond of them. And they behave exactly as in their natural surroundings.

which was killed by the hundreds of thousands for the sake of its lovely plumage, found itself on the threshold of extinction, the English publisher, Sir William Ingram saved it at the cost of almost complete financial ruin. He spent nearly all his fortune to purchase the tiny island of Little Tobago (its entire territory was some 180 hectares) where he brought about fifty birds of paradise. The island, as his private property, was inaccessible to procurers of the birds' feathers. It was thanks to the selfless act of Sir William Ingram, to the care his sons took of the birds, after his death, and subsequently, to the measures of the government of the young state of Trinidad and Tobago, that this tiny island is to this day inhabited by the rarest of birds known as the great emerald bird of paradise.

But Durrell was not only inspired by these examples. He knew that there were any number of animals people would never protect, for they found nothing particularly attractive about them. Here is one example. Some rats were brought by chance to the Antilles. The rats multiplied rapidly and virtually overran the islands, so several mongooses were brought to fight the rats. The mongooses multiplied quickly as well and very soon destroyed all the rats. When there were no more rats left, the mongooses started on the birds that built their nests on the ground. After disposing of them, the mongooses applied themselves to shrews, lizards and frogs, and nearly put an end to all these animals as well. These were useful animals who devoured great numbers of pests; more important still, many of these frogs, toads, birds and other animals were endemic to the Antilles — that is, they did not live any-

This lemur is quite happy in his new home, the zoo.

where else. So their destruction meant their complete extinction.

Frogs, lizards, toads, snakes, newts — do we need to protect and save them as well? Yes, we certainly do. For Durrell, there are no "good" or "bad" animals, useful or harmful ones, interesting or uninteresting. They are all part of the natural community of animals, so they have to be saved and put back into their natural ecological niche.

And it was for the purpose of saving animals that Gerald Durrell set up his zoo.

The royalties which Durrell received for his books — and his books are among the most widely read in the world — enabled him to go on an expedition, to bring back a collection of rare animals and set about organising his zoo. But the British authorities met his idea without any enthusiasm whatsoever. Another zoo? Weren't there enough of them already? Saving rare animals, including frogs and snakes? That was beyond their comprehension.

Durrell, like the Grzimeks before him, knew well enough that though it was prepared to spend millions of pounds on guns and tanks, the British government could not be expected to subsidise the saving of lions and giraffes, to say nothing of toads and lizards. Nor did he count on any material aid. All he asked was permission to set up a zoo. But even here he met with refusal.

But here, luck helped him, and he managed to set up a small zoo on the tiny Island of Jersey.

Several years passed. The authorities were wary of Durrell and his venture; the "man in the street" considered it a crazy whim, and the scientific world was not yet aware of its importance.

The financial position of the zoo was rather precarious. Durrell was very much in debt, and his creditors were demanding money, threatening to cease all deliveries and starve the animals. More than once, it was touch and go, and if not for the courage and persistence of Durrell himself, his wife and their staff, and if not for the help given by friends and nature enthusiasts, known and unknown, there would probably be no zoo on the Island of Jersey today. This zoo is now world famous, and the authorities not only acknowledge but take pride in it (although they still do not give it any financial backing). It attracted many of the world's zoologists. At this zoo, rare animals are not only protected but bred, to be later released and reintroduced to conditions of freedom. Quite a few among them are practically extinct and are not protected anywhere else in the world.

Little Jerry's dream has come true — he has a zoo of his own which he need never leave and where he can always be with his animals.

The dream of Gerald Durrell the naturalist has also come true — he need no longer part with the animals he brings home from his travels. And the main thing is, he is working towards the important goal of saving rare animals.

"I realise," says Gerald Durrell, "that the part we can play here is only a very small one, but if by our efforts we can prevent only a tiny proportion of threatened species from becoming extinct, and by our efforts, interest more people in the urgent and necessary work of conservation, then our work will not have been in vain."

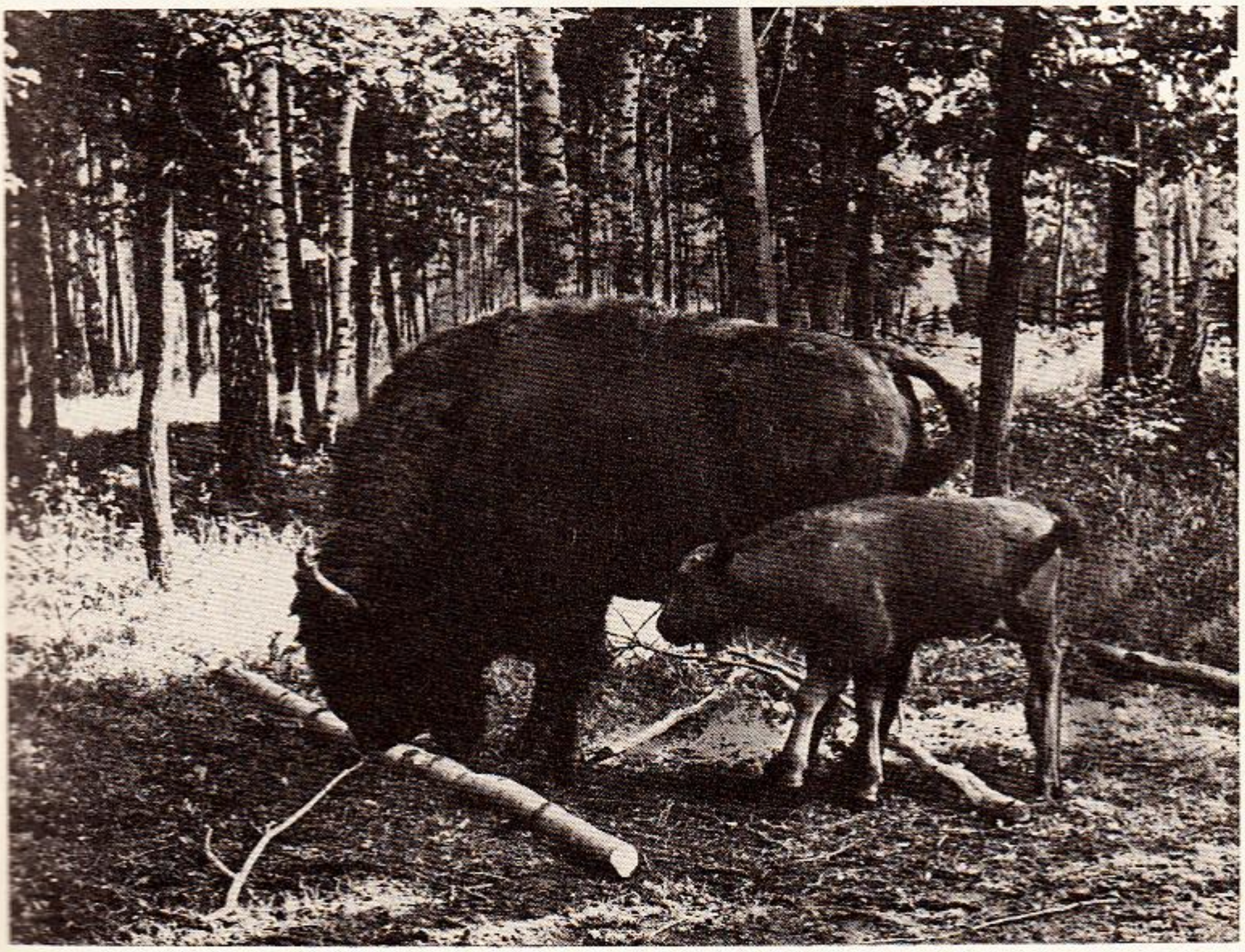
Valuable as the Jersey Zoo is, it cannot solve even a small proportion of the problems entailed in protecting and saving animals. All people must understand how important it is and how urgent is the need for action.

Both Gerald Durrell and Bernhard Grzimek write books, wonderful books, as wise, bold and kindly as they themselves are. They speak on the radio and appear on TV, publish articles and deliver lectures. They explain, urge, persuade, and recruit supporters into their great army of animal lovers and protectors.

Bisons in Moscow Environs

The night mist still clung to the ground under the bushes, but the sun was quite high and would soon dispel it. On that early morning, I came to the forest to see the bisons, some of the biggest, rarest and most ancient dwellers of our planet — contemporaries of the mammoth. Yes, those very bisons which were almost fully destroyed several centuries ago.

A wonderful silence reigns in the forest at this hour of the morning. The chorus of birds' voices greeting the

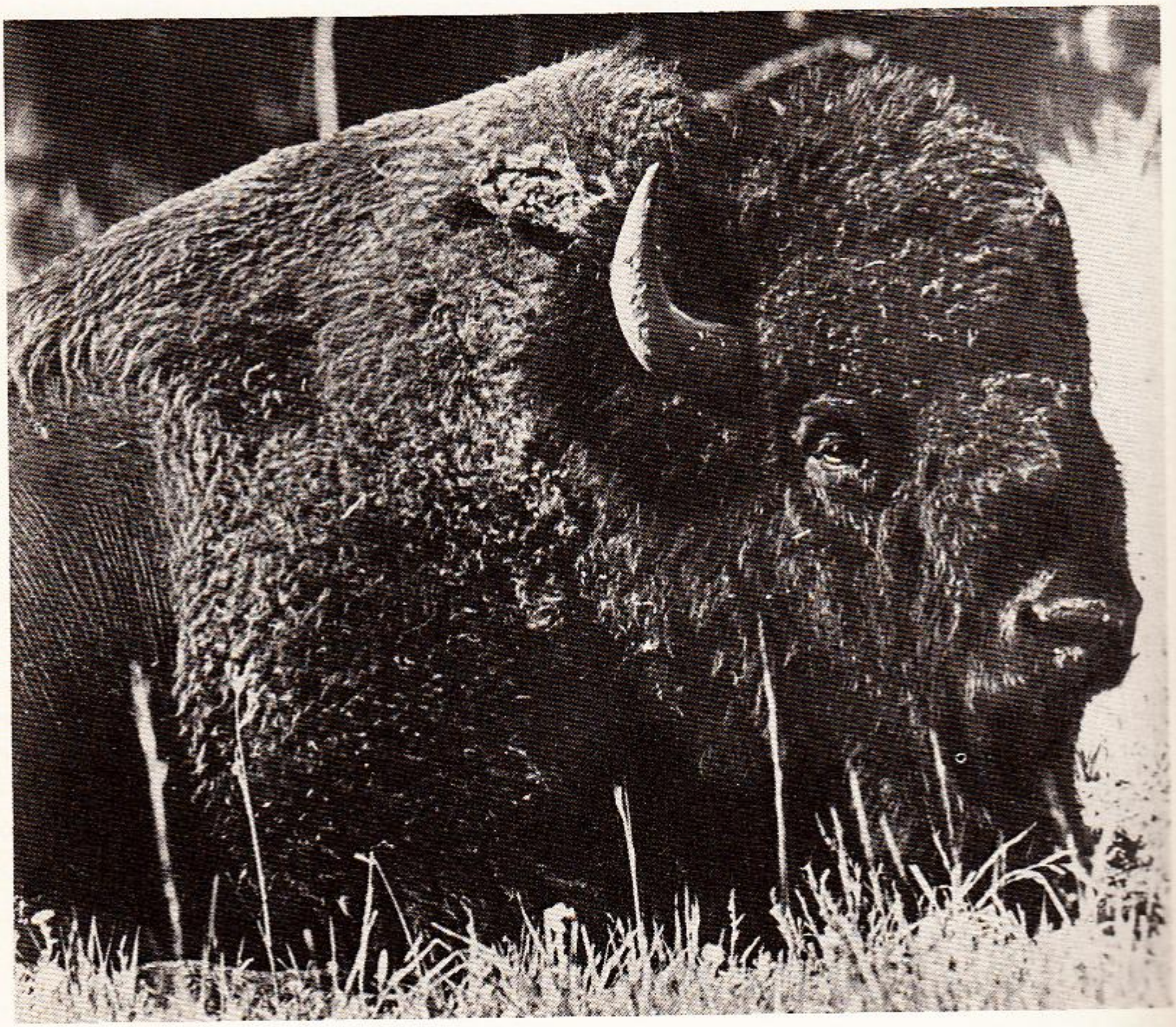


It took some time for zoologists to arrive at the conclusion that the woods in the environs of Moscow are an ideal place for a bison preserve.

sunrise does not destroy but rather emphasises it. And suddenly, it is shattered by the sound of a hunter's horn.

I had been expecting it; I knew it was a signal of summons for the bisons. They would come any moment now.

Several minutes later, different sounds invaded the silence: the crackling of brushwood, snorting and champing. Here they came! I was prepared for the meeting, but when out of the golden mist of morning came the bisons, huge, big-headed, with broadly spaced curved horns, my heart pounded. And not merely because the animals were an exciting sight, but because they were man's own handiwork, as it were, having been resurrected from the dead in the literal sense of the



His ancestors were the mammoth's contemporaries.

word — resurrected by man's knowledge, patience, and — last but not least — by man's great love for animals.

As soon as the First World War was over and men returned to peaceful pursuits, they remembered the bisons. Was it still possible to save them, or was it too late? In 1923, on the suggestion of the Polish naturalist Jan Sztoleman, an International Society for the Salvation of Bisons was set up. The Society had at its disposal 56 bisons, which lived in the zoos of 15 countries. This was very little of course, but still it was something to start with. As it transpired, almost half of the surviving bisons were old, and there were hardly any specialists (indeed, how could there be?) who knew the biology of these animals. So, when the bisons living in Germany contracted some kind of disease, nobody could cure them, and they all died.

Even the question of the bisons' diet remained rather obscure. Some considered that bisons needed grass and that they ate tree twigs and leaves only when there was a shortage of grass (this view lay at the root of the failure to acclimatize bisons in the Askania Nova preserve in 1921), others were convinced that since bisons were forest dwellers (it was no accident that they lasted longest in the Byelovezhskaya Pushcha thickets) they needed only arboreal food. People were unable to understand that the bisons had not retreated into the thickets because they liked it; they had simply been driven there by man's persecution. There were many other things about bisons men did not know then. As the result of this ignorance, within the five years after the formation of the Society, by 1927, the herd of bisons, far from growing, was reduced to 48. And it kept on shrinking: another five years later there were only 30 bisons left — in Poland, Hungary, England, Germany, the Netherlands and Sweden (according to the information in the first *Breeding Book* to be published).

It is hard to say how things would have developed further. As likely as not, bisons would have continued to die out until zoologists registered the death of the last bison in a zoo, just as they had registered the death of the last passenger pigeon and the last quagga. This would most probably have happened had not two American zoologists, the brothers Heinz and Lutz Heck, thought of crossing the European bison with its American cousin, the buffalo.

The brothers Heck would not have conceived this wonderful idea had there not been buffaloes living in the national parks of the United States and Canada and on some farms, and, most important of all, had there not been the bisons of Walking Coyote.

For decades, buffaloes fed and clothed the American Indians. Then the time came for an Indian named Walking Coyote to repay them. With great difficulty, he caught two calves which had by some miracle survived the massacre, a bull and a heifer, and reared them to maturity.

It was very difficult for the Indian to keep them hidden from the buffalo hunters who roamed the country, nosing out the remaining animals; and not just hunters: any tramp, adventurer or bandit would be only too glad to shoot down a buffalo and an Indian as well. But Walking Coyote was a brave and stubborn man. He hid his animals and drove them away at the least sign of danger. He literally nursed the first calves to be born. And thus he lived for twenty-three years, in constant

danger and worry. But the herd kept growing, and twenty-three years later, it already numbered 300 heads.

But the now aged Walking Coyote found it ever harder to hide his buffaloes. He knew he would protect them as long as he could breathe. But what would happen when he fell ill and died?

Fortunately for him and his bisons, the American authorities and general public had by then become aware of the fallacy of bison slaughter. In 1905, a Society for the Protection of Bisons was set up.

The government bought Walking Coyote's buffaloes, and they formed the nucleus of the bison herds which again, although in incomparably smaller numbers, roam the plains of the United States.

It was these buffaloes, or rather, the cows of this herd that the Heck brothers suggested crossing with European bisons. The method of restoring the species of the European bison suggested by the Heck brothers was called absorbing crossing. This is what it means: the crossing of European bisons with American cows produced cross-breed calves. The females of these were again mated with European bulls, their offspring mated with European bulls again, and so on.

The first offspring of the mixed marriage was half-bison, half-buffalo. The second generation was one-quarter buffalo and three-quarters bison, and it had many more features of the European bison than of the American buffalo. The next generation was only one-eighth buffalo and was little different from a pure-bred bison, and the fourth generation, which had only one-sixteenth buffalo blood, was so nearly pure-bred bison that even specialists could not distinguish them.

In many localities wolves still do great harm to domestic cattle and are hunted by man.

They do have some buffalo blood after all, but to all practical intents and purposes they are European bisons.

Many specialists opposed the Hecks' idea, but when work was begun they soon changed their minds.

In the first place, the hybrids were more viable and resistant to disease than their parents; second, the crossing accelerated the work of bison-breeding incomparably; and third, if the method of absorbing crossing had not been adopted, close relatives from the small bison herd would have to be mated, and that would have led to the speedy degeneration of the herd.

The Second World War inflicted considerable losses on the bison herd. Still, the *Breeding Book* published after the war listed 98 bisons.

In 1946, there was only one purebred bison in the Soviet Union. Two years later Puslow, a bison which was a cross between the Caucasian and the Byelovezhskaya breeds, arrived in the Soviet Union from Poland. And he was brought to the woods of Moscow Region, where a bison herd was to be started. Yes, it was in the vicinity of Moscow, on the territory of the Prioksko-Terrasny preserve that it had been decided to set up the Central Bison Nursery, where bisons would be acclimatized and bred.

One of the most authoritative bison specialists, Mikhail Zablotsky, had proved that what bisons needed was not the steppe with its abundant grasses and not the forest where there was almost no grass at all. Bisons thrived in thin mixed woods with plenty of glades and copses. And these were precisely the conditions which prevailed in the Prioksko-Terrasny preserve.

Puslow was followed by another bull and two cows in 1948. And today, the sound of hunter's horn was answered by dozens of powerful beasts who sauntered out of the woods and made for the feeding troughs.

Bisons are not choosy about their food: they eat the leaves and bark of 30 species of trees and 150 various grasses. There is plenty of food available in the woods, but all the same, the bisons' diet is supplemented with oats, bran and root crops, and in winter with hay also. Why is that, you may ask. After all nobody gave bisons any fodder when they roamed free, and yet they were all right. So why should they be mollycoddled now?

Naturally, they can do without oats and hay and will not die; they will live just as their free ancestors lived. But this is precisely the snag as far as the workers of the preserve are concerned. Bare survival does not satisfy them. They want bisons to prosper and multiply. And multiply as quickly as possible.

When bisons lived in the wild, nobody cared about their numbers. Usually a cow calved once in two or three years. The calves were often weak, and many of them died. In the preserve, on the other hand, bison cows have calves every year and almost all of them survive.

That is why ten years after Puslow's arrival in the USSR, 280 of these rare animals were living in the various zoos and preserves of our country; of them, 19 were American bisons, 182 crosses between American and European bisons, and 79 European bisons. Today European bisons have considerably increased in numbers and are being resettled to other wild nature preserves in the Soviet Union.

...Having cleaned the troughs, the bisons again disappeared into the forest

until evening. At 6 p.m. the horn would blow again and the bisons would come for feeding once more. In the meantime, they would roam in the woods, look for mushrooms and nibble grass. They would not go far — bisons are not affected by *Wanderlust* and do not walk more than 5 to 7 kilometres a day.

Until the age of three, the bisons all live and graze together. In the fourth year they are divided into breeding groups and placed into enclosures — after all the preserve has various strains of bisons: those from Byelovezhskaya Pushcha and from the Caucasus, as well as crosses between the European and American bison.

In nature, bisons are wary and it is difficult to see them. Far from attacking man, they go out of his way to avoid a meeting with him. They have keen hearing and the moment they hear an approaching man they move out of his way.

In the pens, on the other hand, they quickly get used to the people who take care of them, respond to their names, come close, and permit the people to pat them. That, of course, is not a general rule, for animals differ in character as much as people do. But on the whole, these huge and fearsome-looking beasts are quite good-natured.

Workers of the preserve recount with amusement the story about filmmakers who came to the preserve in hopes of filming terrifying scenes of bisons chasing people, butting cars with their formidable horns, and battering brick walls. Great was their disappointment to discover the bisons were really quite peaceable animals. They went home without any spectacular shots and nursing a suspicion that they had been made fools of.

This bird eats insects, but it cannot be regarded as a predator.

Yes, bisons are peaceable animals. And man can be proud of the fact that they still live on planet Earth. The fact that bisons live near Moscow and are sent from there to other parts of the Soviet Union is a great victory for Soviet zoologists, in particular Mikhail Zablotsky.

Predators — Harmful or Otherwise?

An unusual memorial stands in the Welsh town of Carmarthen. It was erected in 1880 to a wolf, or, to be more precise, to the last wolf to be killed in Great Britain.

And there are also localities where wolves are protected: people have finally understood that predators have their own function in the cycle of life.

For centuries, the people living on the British Isles waged a persistent war on wolves, which in the late 19th century ended in man's victory over the predators.

Wolves are strong, cunning and tenacious animals which adapt well to any conditions of life and endure both cold and hunger well. A wolf can pursue his prey for several hours on end, at times reaching the speed of 80 kilometres an hour. They are extremely voracious, and after a long fast, a wolf can eat as much as 25 kilos of meat at one go. When hungry, wolves become audacious and attack well-guarded flocks, invade cattle sheds and sheep pens. According to the estimates of specialists, before the Revolution of 1917, some 750 thousand heads of cattle and sheep were killed by the wolves annually in European Russia alone.

It is no wonder, therefore, that people fought wolves with all the means at their disposal. In Kazakhstan, in the course of only five years, about 80 thousand wolves were destroyed. But they still wreak havoc upon domestic herds, and the war against them is still going on. Perhaps the day will come when a monument will be erected to the last wolf in our country as well.

"And a good thing too," some people will say.

"Not so good," others will object.

Why? Aren't wolves predators? To be sure, they are. But let us stop and consider the implications of the term.

It seems clear enough: predators are animals who eat other animals. On the other hand...

The beetles carabus and ladybird are predators, for they eat other insects. The blue titmouse, which also eats insects, is not a predator but an insectivorous bird. The pike is a predatory fish. But the kingfisher, who also eats fish, is not a predator but a fish-eating bird. This list could be continued *ad infinitum*. There are examples of the opposite as well. The crow, for instance, is not considered a bird of prey. But it is common knowledge that it eats other birds' eggs and fledgelings. Gulls are regarded as fish-eating birds, but they destroy a great number of rodents as well. And, lastly, there are quite a few animals which are considered predatory but which prefer to eat plants or insects.

The term "predator" is thus a loose one, so, in order not to get lost in all the complications, let us be guided by the lay (and not the scientific) definition of predators. Let us apply the term to those animals which eat their own kind: insects which eat other insects, fish which eat other fish, birds which eat other birds and mammals which eat other mammals.

Very well, the supporters of the monument to the last wolf will say exultantly, that puts everything in its proper perspective. Predators should be destroyed, because they destroy domestic animals and because they destroy wild ones as well. If we want to preserve, say, the hoofed animals, we must get rid of the wolves and the lynxes; if we want to preserve the song birds or the insectivorous birds, we must get rid of owls and hawks. Isn't it obvious?

Why, then, do Polish zoologists recommend restricting the hunting of wolves instead of placing these animals outside the protection of the law?

Why does the British zoologist Professor G. B. Happ think that wolves

There are not many polar bears left on our planet. We shall know exactly how many after their census is completed.

must be brought and resettled in Scotland all over again, in the very localities where people took such pains to get rid of them 300 years ago?

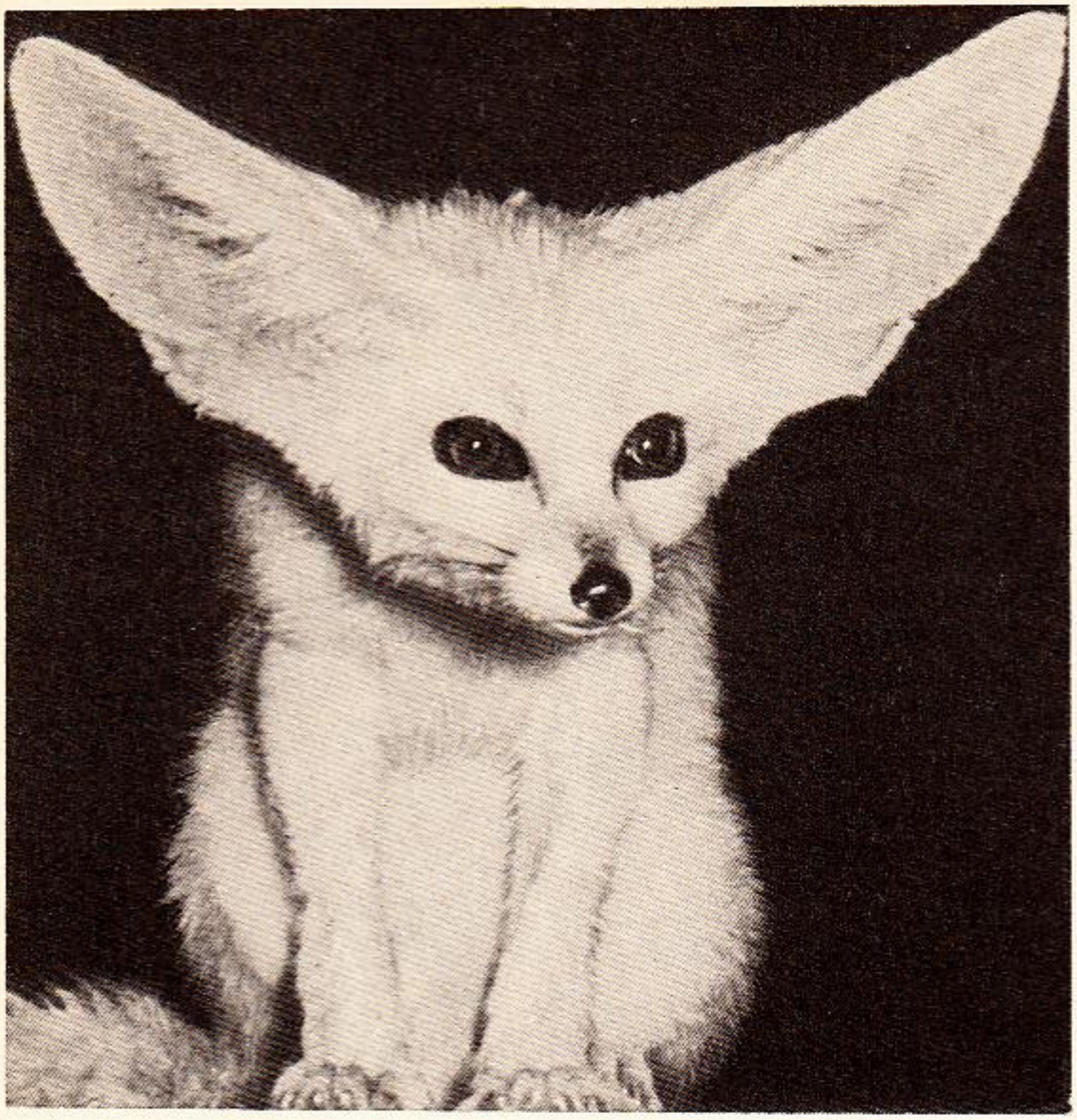
Why is the hunting of the lynx prohibited in the GDR, Finland, Yugoslavia and many other countries?

Why is the bear protected by the state in many countries, and the shrinking number of polar bears (there are about 10-14 thousand of them left, and the killing is still going on) viewed with alarm by zoologists?

Why are zoologists so concerned about the destruction of tigers?

Why have people begun to reconsider their views on predators which took shape over the millennia? The more man learns about animals, the clearer it becomes that interference in their life must be very circumspect, that the relationships which have been formed and consolidated over the ages cannot be tampered with unthinkingly. This does not mean that predators should not be killed at all. If there are many of them, if they inflict great losses on domestic animals and kill too many wild animals, they must be destroyed. But only within certain limits. That much has now become perfectly clear. It was only recently that people learnt to conduct an effective fight against predators and even destroy them totally in some regions. The results were not at all encouraging. Signals of warning began to come in: be careful, look before you leap!

Here is an example. The Americans decided to save the deer herd on the Kaibab Plateau in the state of Arizona. The deer suffered great losses from predators — pumas and wolves — so people began to destroy these predators. Before long, there was not



The fennec fox is a real predator.

a single puma or wolf left in the locality.

This seemed to be excellent cause for rejoicing. Indeed, the deer herd began to grow quickly. But the people's joy proved premature; several years passed, and the deer began to fall ill and die *en masse*. Soon there were fewer of them left than there were before the wolves and pumas were destroyed. In another few years, the deer on the plateau were threatened with complete extinction.

And the reason was the predators, or rather, their complete absence.

That seems illogical. The absence of predators should have facilitated the growth of the herd. After all nobody was killing the deer any longer.

In actual fact, the relationship is much more complicated. And before interfering in the life of an animal community, man has first to stop and reckon things up. (Reckoning and counting is useful not just in wildlife preserves, by the way!)

People must constantly remember that their actions today are bound to have consequences, whether in a year or twenty years. But consequences there will be, and not always desirable ones.

The Americans destroyed all the predators in the district, and soon the

deer herd increased. The aim, it would seem, had been achieved. But those who favoured this drastic measure did not know how to count and reckon, or did not bother. Otherwise they would have realised that the increased numbers of deer would devastate the plant life and, having destroyed it, the deer would start to die of hunger.

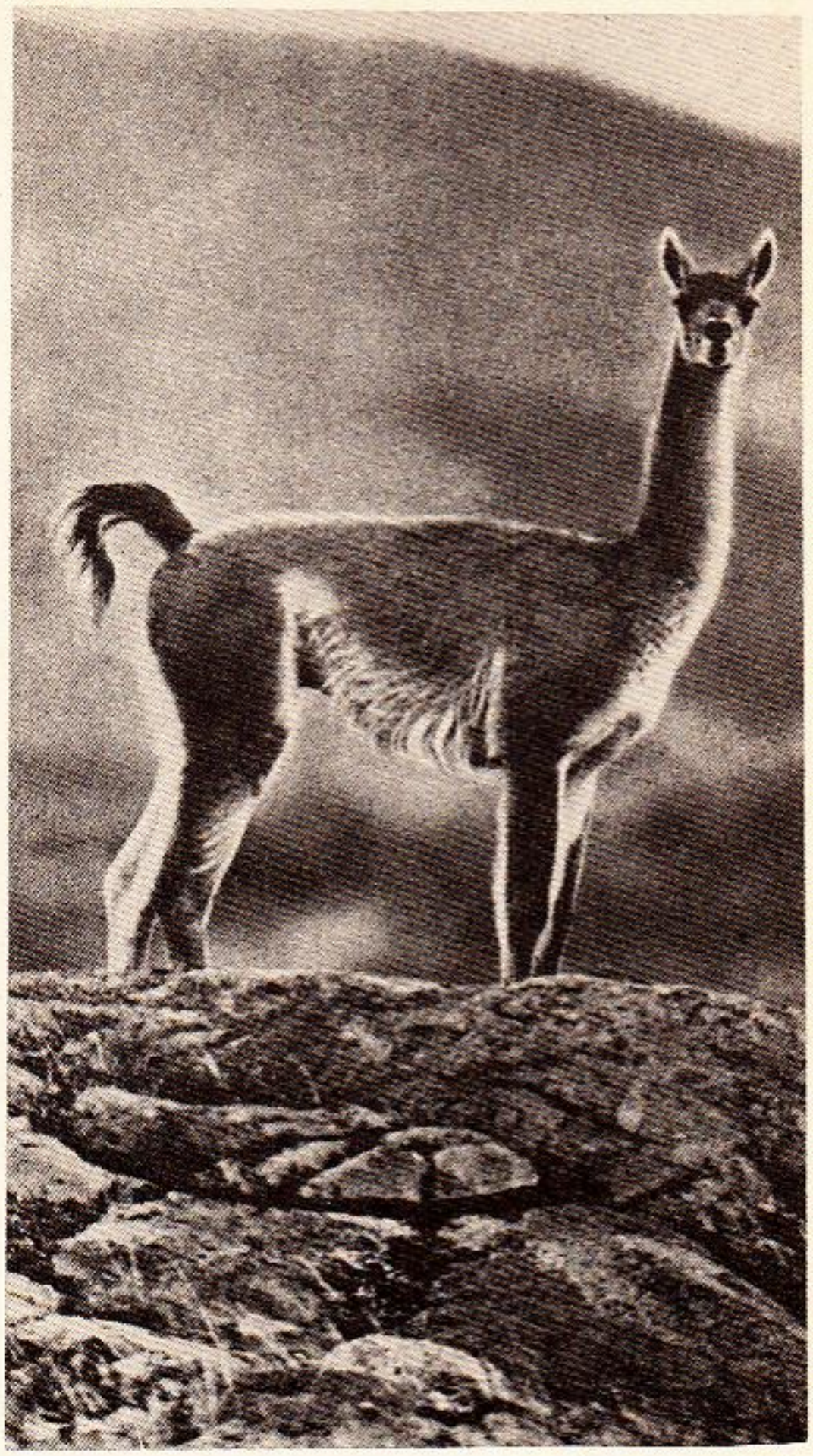
Starvation, however, was not the only result of the total destruction of predators: the deer began to fall ill, and diseases spread fast. The people who had destroyed the predators did not know that predators regulate the numbers and do not let the animals multiply excessively, and in this way prevent the spread of epidemics. They not only eat dead animals, which are a source of infection, but they also destroy weak and sick animals — carriers of disease — and thus cut short its spread.

All this was unknown to or ignored by the would-be protectors of the deer in Arizona.

Similar results followed the destruction of wolves in Canada in the localities populated by the now rare caribou reindeer.

Charles Darwin wrote that the ancient Incas of South America had a good method of rounding up lamas. They sorted out the captured animals and released the strongest and most beautiful. They killed only weak animals for food. Not ill, mind you, merely weak. While the strong and the beautiful were left to continue the species, and it flourished.

The wolves accomplish approximately the same function. In the first place, they destroy sick animals, and in the second, weak ones. (Not consciously, of course, but merely because weak animals are easier prey.)



The llama, the South-American kinsman of the camel.

Thus, by killing off the sick and the weak and leaving the strong, they promote the improvement of the species.

Nor is this all.

Leopards are regarded as very dangerous animals in Africa, though

man-eating leopards are very rare. Nonetheless, people hunted these animals persistently and achieved certain successes on the road to their destruction. But as the result, herds of baboons, whose numbers were growing from day to day, began to raid the plantations in Kenya.

As was subsequently established, leopards had been regulating the numbers of baboons, preventing them from multiplying to a dangerous extent. And it was far more difficult to fight these swarms of baboons than to kill off leopards.

Here is another example.

Coyotes were hunted mercilessly in the United States, since they were rightfully accused of killing lambs. In 1962 alone, 90 thousand dollars were spent in California on the destruction of coyotes. But when the harm done by these animals was calculated, it amounted to only 3.5 thousand dollars. Moreover, this, too, is an exaggerated figure; many American zoologists are of the opinion that coyotes, when all is said and done, do not do any harm whatever. On the contrary, the coyote is a useful animal. It is not lambs that constitute its staple diet, but rodents, which harm the pastures.

So, if the harm done by the coyote as the killer of lambs is weighed against the good done by it as the killer of rodents, the sum total comes out in favour of the coyote.

All that has been said about predatory beasts largely applies to birds of prey as well. People's attitude to these birds has been negative since time immemorial, for do not kites carry off chicks? Do not falcons kill pigeons? And hawks kill everything they set eyes on, including such large birds as wood grouse.

In other words, all birds of prey were considered brigands.

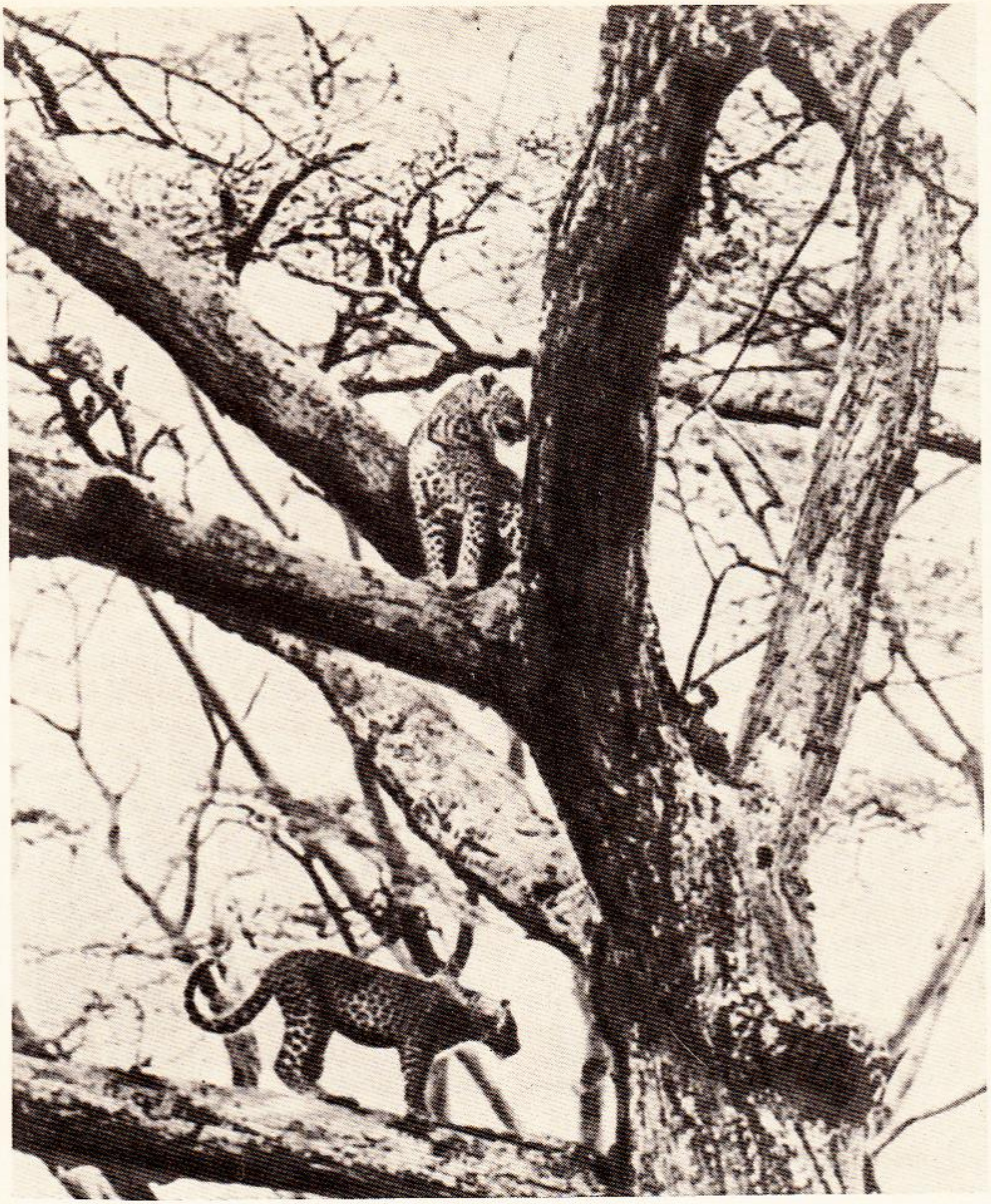
That is what a bird of prey is actually called in German — *Raubvogel* — "brigand bird".

Well, nobody is going to deny that birds of prey eat other birds. But not everybody knows that birds of prey do not kill very many birds. Zoologists have estimated that songsters, game and other birds constitute no more than 10-15 per cent of the predatory birds' fare. The rest is accounted for by harmful insects and rodents. This is a proven fact, and many birds of prey are protected today. Not all hunters are aware of the prohibition, however, and the destruction of predatory birds continues.

According to very modest estimates, more than a million birds of prey were killed in the Soviet Union every year. The same happened elsewhere. In smaller countries, the predatory birds were almost completely annihilated. In England, for instance, only several pairs of ospreys have survived. Thousands of tourists make a pilgrimage every year to have a look at these birds, recently so widespread and now so rare.

The same fate awaited hawks in England, but the government issued a law prohibiting their killing. Some other birds of prey are also protected in Belgium, the GDR, Federal Germany, while the Netherlands have specially imported 40 pigeon hawks and promised bonuses to farmers on whose lands they build nests.

Naturally, people began to protect birds of prey primarily because zoologists proved that they do a lot of good by destroying agricultural pests. But their usefulness is not confined to this. Like the predatory mammals and pred-



Jaguars.

atory fish, these birds promote the prosperity of the bird population.

People came up against this phenomenon long ago but were unable to appreciate its import fully and did not draw any practical conclusions.

Yet there were plenty of facts to go on!

At the turn of the last century, nearly a thousand birds of prey were destroyed in Byelovezhskaya Pushcha in hopes that this "measure" would result in an increase of game. But the amount of game, paradoxically, decreased. Apparently, the results of this "experiment" were not known in Norway, or its implications were not understood, since the Norwegians repeated it in the early 20th century in hopes of increasing the numbers of white partridges. Indeed, at first, the numbers did go up, and hunters were ecstatic. But beginning in 1916, the white partridge population began to shrink sharply, and several years later the hunters were able to procure not more than 700 or 800 birds in a year, where they had formerly bagged 12-13 thousand.

In 1927, Norwegian zoologist August Brinkmann established the connection between the destruction of birds of prey and the decrease in the number of partridges. But many more years had to pass and millions of birds of prey had to be killed before the truth of his assertion was driven home — and not everywhere or with everyone.

Now we know: predators are necessary for the normal life of other animals. To kill off the predators means to do much greater harm to these other animals than is done by the predators themselves.

We know today that predators primarily kill sick animals, but not because they like their taste better. They attack all animals without distinction. But the healthy ones stand a better chance of getting away than the weak or sickly ones.

A prominent Soviet ornithologist, N. A. Gladkov, conducted observations of the hunting done by birds of prey in Kazakhstan. In was calculated that out of 3,441 attempts to catch the prey only 213 were successful — i. e., 6.1 per cent. We are justified in saying with assurance that the birds who fell prey to predators are primarily sick or weak ones.

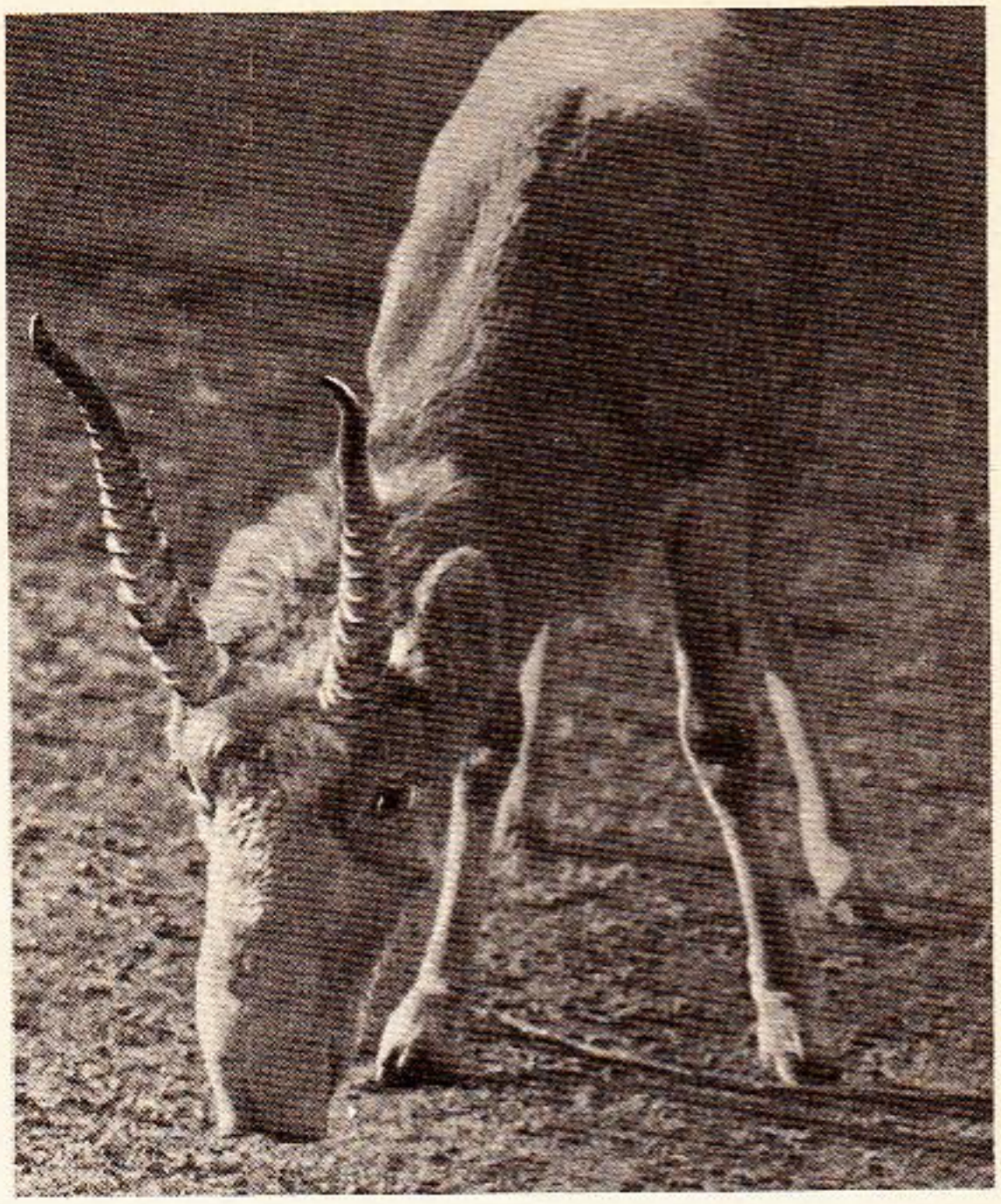
So predators, which numbered (and justly in many cases) among the agents in the destruction of many animals or even entire species are necessary under certain conditions and in certain numbers for the prosperity of these same animals.

Problems Galore

It is easy enough to destroy animals. It is much more difficult to restore their numbers or even to discontinue the destruction.

Of course, laws are necessary. And there are plenty of them in many countries and there are international laws and agreements on the protection of nature and specific animals. If these laws are rigidly enforced, they help to save animals. An example of this is provided by the elk and the saiga in the Soviet Union.

Saiga antelopes are among the most ancient hoofed animals living in this country, and until quite recently, they were also the most numerous. At the beginning of the last century, travellers wrote about countless herds of saigas roaming the steppelands of



Not so long ago the saiga antelope was heading for complete extermination.

Europe and Asia. But in the second half of the last century, the situation changed. Thousands of hunters went after the saigas, valued for their meat and skin, and they were quite easy to kill, too. A participant in a hunt at the end of the last century admitted that it was a "barbarous, cruel slaughter" rather than a hunt. The saigas were driven into large pits, the bottoms of which were spiked with sharpened reed stalks. "There was the first saiga driven onto a dry, sharp reed stalk and impaled on it like on a spit, then another fell, and finally, the entire herd was slaughtered... When the next herds fall onto the corpses of the dead ones, ninety hunters jump out and an even more disgusting massacre follows. They no longer kill but just slit open the bellies of the unfortunate beasts. At last, having tired of killing, they wave and shout to the riders. Those come up and pitch in with their knives. What a bloodbath! More than 12 thousand head were killed on that one occasion!"

And this description deals with only one such massacre, while they occurred by the thousand. No wonder, therefore, that by the beginning of the 20th century, practically nothing remained of the million-strong saiga herds. Yet the destruction went on, and by 1919, not more than a thousand saigas survived. In 1919, a law was passed prohibiting the hunting of saigas under pain of severe punishment. But an entire decade passed before the saiga herd showed any signs of increas-

An owl destroys about a thousand rodents in a year and thus saves us almost a ton of grain.

They are still little, but they already do a lot of good to man.

ing. Then the process began to pick up momentum, and today, there are at least a million and a half saigas in the Soviet Union.

About the same thing happened to the elks. Their numbers began to dwindle as early as the 17th-18th centuries. By the beginning of the 20th century, elks had disappeared completely in many regions and were rare in those regions where they still lived. In 1919, Lenin signed a decree prohibiting all hunting of elks. As a result, in 1963 (despite the great destruction wrought in the elk population by the Second World War) there were, on the territory of the Russian Federation, several hundred thousand head.

The fate of the saigas is highly characteristic in that it shows both how very numerous animals can be destroyed within a short span of time and how strict observance of a law can help to save them.

Unfortunately, the law sometimes proves powerless to save a species.

A modern landscape.

An example is provided by the American golden eagle. Although the penalty for the killing of a golden eagle in the United States is a fine of 500 dollars or six months in prison, golden eagles are still being killed. The same is true of California condors, of which no more than three or four dozen are left.

But in addition to the destruction wrought by poaching, people concerned with the protection of animals are faced with many difficult tasks.

Men cannot stop building roads and canals, dams and airports; they cannot stop ploughing up land, and cities will continue to expand. This puts pressure on wild animals, for when woods are cut down, swamps drained, and steppelands put under the plough, animals are deprived of their natural habitat. In each case, a solution has to be sought. Zoologists may press for a decision to retain some areas in their natural state, or they may transfer the bigger animals to preserves, or reconcile themselves to having the animals caught and kept only in zoos.

Even the most well-intentioned of man's activities may prove deadly to animals. For instance, to maintain a forest in good condition, people cut down old trees that are hollow inside. This entails an immediate reduction in the numbers of useful birds which make their nests in hollow trees. If there are no hollows, they cannot hatch their young.

So zoologists and nature lovers build all kinds of bird houses, but this is quite a complicated task too, for one must know what kind of house is required by each species and where it ought to be hung.

Still, bird houses help to maintain the bird population. Nor does this apply only to birds nesting in tree hollows. Zoologists from the GDR have started hoisting special metal baskets onto high-voltage line supports. These have proved very acceptable nests for ospreys, and the number of these useful birds has grown considerably.

Civilisation creates many other dangers for birds. Many of them, for instance, are dashed to death against all kinds of structures. On a Pacific island, in the course of two years, nearly three thousand Laysan albatrosses died from crashing into the lighthouse as they flew. On the Atlantic coast of the United

States, one television tower takes the toll of more than two thousand birds every year. During migration flights, hundreds of thousands of birds perish, smashing themselves to death against masts, towers, lighthouses and simply wires. So zoologists are busy racking their brains to invent a warning device for the birds.

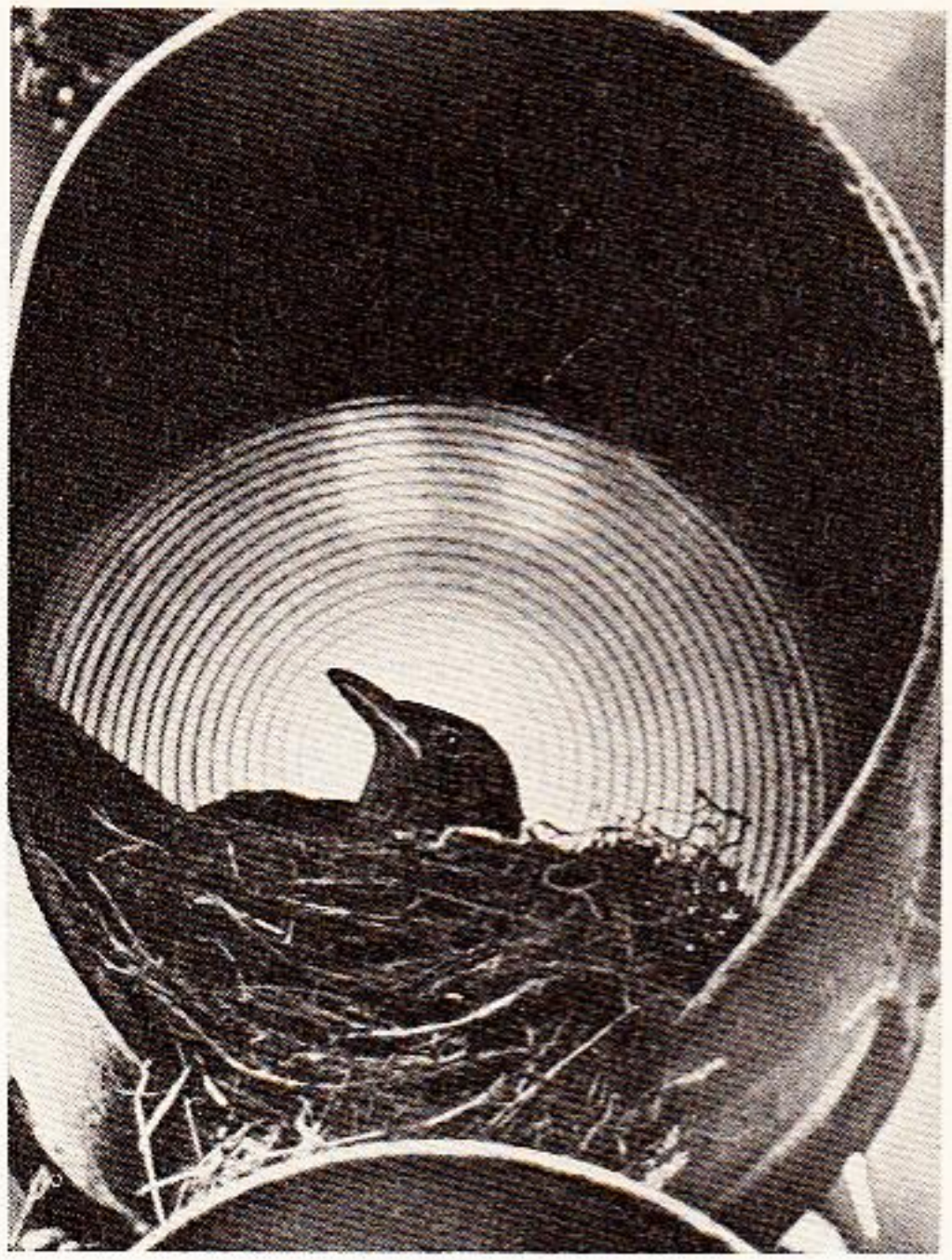
New problems are posed every day, with new danger signals arriving from the most unexpected quarters. At one time the alarm was given in the United States regarding the danger to something like two million waterfowl. It came from small shot which, failing to hit a bird, fell into the water. Every year, it was calculated, no less than 6,000 tons fell to the bottom of various reservoirs. In many parts of the United States, waterfowl began to perish *en masse* from lead poisoning. Zoologists raised an outcry. Then a new type of shot, in a protective casing, was developed.

But even if birds, and with them fish and all other dwellers of rivers and lakes, are saved from lead poisoning, there are other poisonous substances dumped into lakes and rivers by various factories.

In those reservoirs where wildlife has not yet been destroyed, where there are still birds and fish to be found, a fight is being waged to save them from bullets and nets. Many people lay the blame for the decrease in fish on the fish-eating birds. Zoologists are hard put to prove that this is not at all the case.

Not only fish-eating birds require protection, but starlings, rooks and even ostriches.

Gunfire comes from fields, orchards and vineyards. Birds are shot down there not for the sake of their pretty feathers but because they do damage. But aren't



Light does not frighten birds. Rather on the contrary — it emanates warmth. So these birds decided that traffic-lights are a good place for a nest.

rooks and starlings useful birds?

They are, there is no question about it. But in nature, it is difficult to pigeonhole things and assert that an animal is a hundred per cent useful or harmful. Even the useful starlings and rooks sometimes wreak havoc upon fields and orchards. The rose-coloured starlings of Southern Europe and Northern Africa sometimes destroy as much as a third or even half of the grape harvest. Our ordinary starlings also harm vineyards in the Crimea and Central Asia. And the rooks, which do so much good for the ploughed field in spring, striding over the ploughland, eating many

dangerous pests, and, generally, "loosening up" the soil for spring sowing, peck up the young shoots of maize at a later date.

In Australia, ostriches are unwelcome guests in wheat fields.

But to kill starlings and rooks (and, mind you, if you want to protect the vineyards, you have to kill great numbers of them), to kill birds which destroy harmful insects and thus do man a great deal of good is a crime! And killing ostriches is a crime, too. So what can be done?

Various rattles, coloured rags, and scarecrows were used to frighten the birds away, but nothing helped. Killing them seemed the only feasible thing to do. But zoologists finally hit on an effective method. It took a long and detailed study of the birds and the use of the latest technology. However, at last a method of saving the birds and neutralising their harmful activities has been devised.

Everybody knows that birds make all kinds of noises. But it took people a long time to realise that the singing of birds is more than mere roulades, that it is a "conversation". Each song and even each sound has a meaning of its own. Fowlers have long used this to lure birds closer, imitating their voices. What they were imitating were "peaceful" noises used by the birds for communication in normal conditions. But there are also sounds emitted by birds in moments of danger. A bird will cry out in fear and all the others will know that they must get away as fast as their wings will carry them. Then there is also the special death cry of a bird caught by a predator.

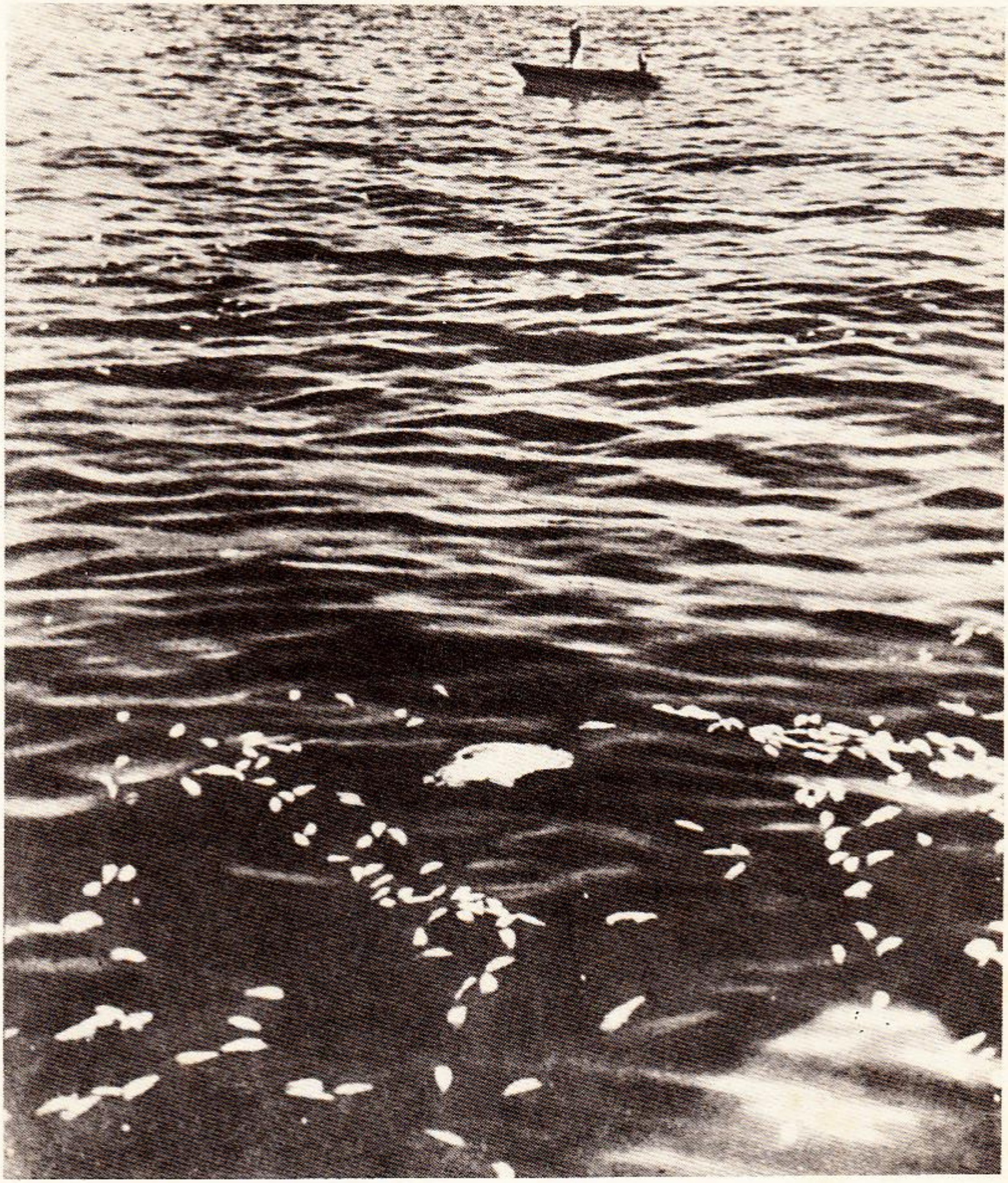
It was this cry that zoologists decided to use. In 1954, the American ornithologist Hubert Frings recorded this "cry of horror" emitted by starlings. Then he reproduced the sound near the birds' resting place at night. The result was quite spectacular. The starlings not merely rose up in alarm in the middle of the night — they left the town altogether.

This seemed to be a very promising avenue. And the method did prove infallible in the case of starlings, crows, jackdaws and rooks, which became alarmed as soon as the tape-recorder was switched on. If the "cry of horror" was repeated, they flew away, never to return. Sparrows, on the other hand, proved very philosophical as regards the plight of one of their numbers. No "cries of horror" scared them away, and zoologists were at their wits' end until they discovered that the cry of a bird of prey reproduced by a tape-recorder took care of the sparrows.

So now we know how to frighten birds away at a time they can do harm to agriculture, while by springtime, when their good services are required, the fear will pass and they will return to the same fields and vineyards. And in autumn they can be frightened away again.

Could the same method be used to shoo birds away from masts and towers? After all it has been applied successfully at airports where a bird can cause an airplane crash.

The building of bridges, dams, hydropower electric stations and canals poses another important task — the saving of fish. Thousands of them used to perish beating against the concrete bridge trusses or dams and during explosions in construction work on rivers, and no amount of effort on the part of the builders succeeded in driving them away. Various methods were tried to save fish — from noise and weak electric charges to tunnels in dams and



Another modern landscape. Poisoned fish.

People discharge thousands of tons of oil into rivers and lakes. Don't they understand that it is more deadly than any poaching?

even special lifts for carting the fish travelling to spawning sites across the dam (this latter in the case of different levels of water on the two sides of the dam). But nothing really helped. The fish refused to cooperate, would not be shooed off the sites where explosions were planned, would not enter the tunnels in the dams but beat against their walls and absolutely refused to use lifts even though they were desperate to go up the river to spawn and then swim back down the river to the sea.

Vast losses of valuable fish might have gone on unchecked had not ichthyologists unfathomed some fishy secrets. Mute as a fish, the Russian proverb goes. But in actual fact, fish are terrible chatterboxes. They carry on conversations all through the day and sometimes at night as well. True, man can detect this conversation only through a special apparatus, but fish can hear one another very well.

There is yet another method of signalling used by fish —"the smell of fear" or "the smell of horror", and when fish detect it, they hasten to make themselves scarce.

Why not try to use it, ichthyologists wondered.

The very first attempt was a smashing success. Now fish could easily be frightened away from dangerous localities, and they could also be lured into fish-conducting tunnels and lifts by attractive promises in fish language.

Unfortunately, these achievements of ichthyology have not yet been implemented everywhere, and in too many places fish continue to perish, failing to understand the purpose of devices built especially for their good. But at least the problem has been solved in principle. All that remains is to put the method into practice.

Meanwhile, new problems arise daily. Man's activities, which seem to have no bearing on the life of animals, birds and fish, suddenly develop dangerous consequences. One such problem, seemingly quite remote from the well-being of animals, is warfare against harmful insects.

Biological, Not Chemical Protection

We have by now realised the importance of arithmetic in the science of biology. It is not only applicable to big animals in a forest preserve and the problem of food supply for them. Counting insects is no less important than counting rare animals which require man's protection. On the whole, entomologists are quite apt at counting. They are able to calculate the number of, say, locusts in a huge swarm that covers the sky and strikes terror into the hearts of African or Arab peasants. A naturalist who chanced to observe

such a swarm calculated that it contained some 25,000,000,000,000 insects and weighed 44 million tons. Even given a margin of error of several billion insects and several million tons, the danger of such a swarm is obvious.

A swarm of such proportions is, of course, rare. But locust swarms numbering hundreds and even thousands of millions invaded our country until fairly recently, and they still attack some African and Asian countries.

Locusts apart, agriculture suffers great losses from hordes of caterpillars, bugs and flies. Besides, many insects are dangerous to man's health and life itself. The ordinary housefly is the carrier of more than 60 diseases, including such serious ones as a typhoid fever and dysentery. It has been found that a fly's intestinal tract contains nearly 28 million bacteria, with another 6 million on its body.

Arithmetic comes in handy not only for counting the number of locusts in a swarm or bacteria in a fly's stomach, but also for making predictions. It has been calculated that the progeny of one plant louse, if it survived in full, would cover the entire globe in the course of a single summer. The same applies to many other insects.

Luckily this is so much theory. In practice, insects never multiply in such monstrous proportions as to endanger life on our planet. Still, enough pests survive to destroy one-fifth of the globe's harvest. And not only cash crops are endangered. In the United States, for instance, insects destroy a hundred times more trees than plant diseases and forest fires do. Man has to pay an outrageous ransom to pests and will not, naturally enough, resign himself to it.

Ever since man started tilling the fields and planting orchards, insects have been plaguing him. At first he fought them with incantations and prayers, then set about devising traps and swatters. But the effect was negligible.

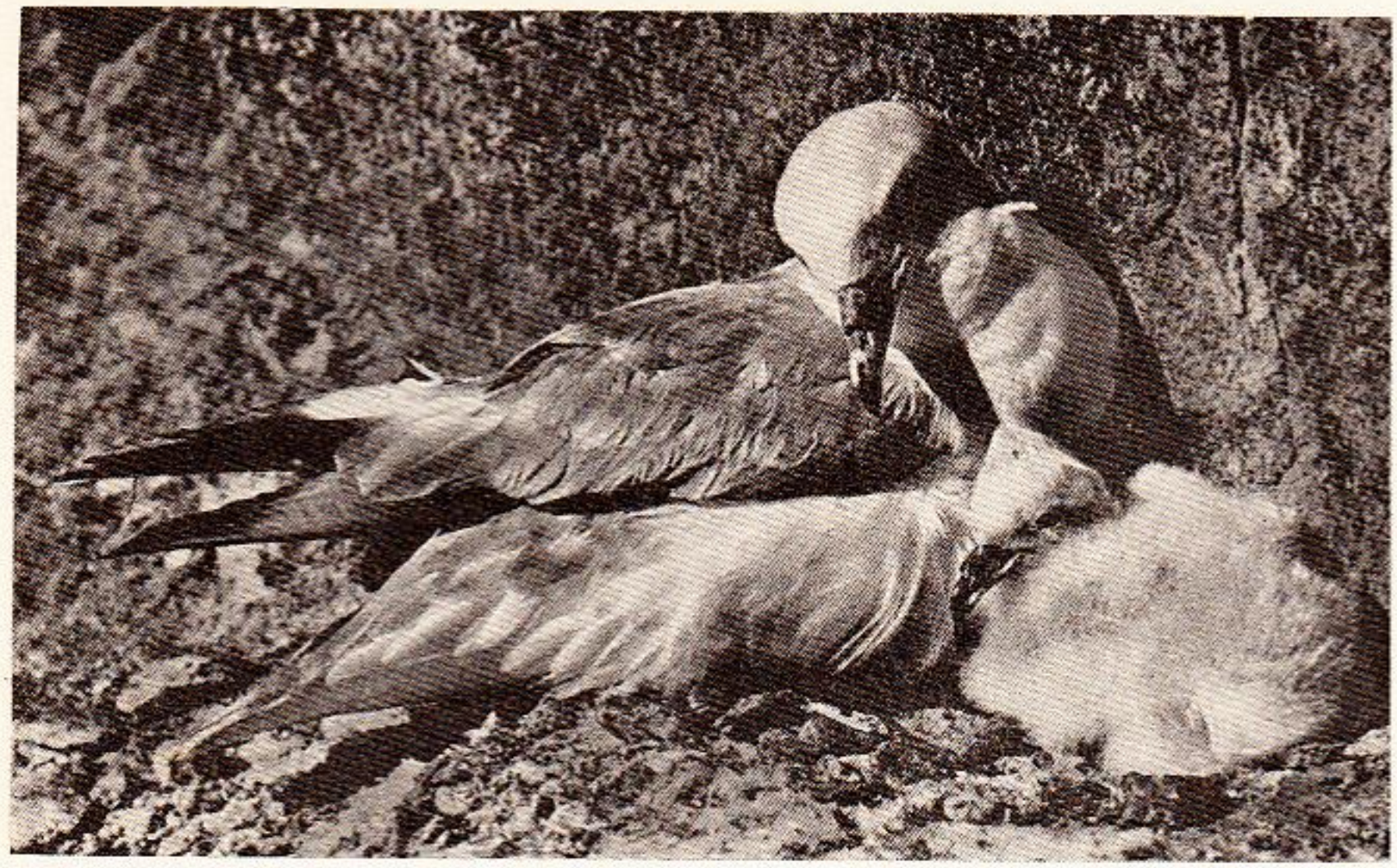
The development of science, especially chemistry, enabled man to score a victory over insects. But a victory, alas, which was incomplete and temporary.

Poisons used to fight insects, pesticides, vary widely in their composition and action, for insects are different and must be fought by different means. Some gnaw plants, and against these, so-called intestinal poisons are used. These get into the insect's intestines with the food and kill it from inside. But however potent this poison, it does not affect the tiny plant louse. For the plant louse does not gnaw a plant but pierces its skin with its proboscis and sucks its juices. So poison distributed on the plant's surface does it no harm.

To combat plant lice, bugs and other sucking insects, contact poisons are applied. They poison the insect by penetrating its surface covering or respiratory tract.

A great many contact poisons have been developed, and they are used as liquids, powders, emulsions, oils and ointments. Engineers work with biologists and chemists to invent all kinds of devices for their distribution, from small portable gadgets to large complicated machines. But however large, they cannot possibly deal with all the vast fields, huge forests, and mountainous regions. So hundreds of aircraft conduct the battle against insects from on high.

In the aerosol method poisonous substances broken into tiny droplets remain suspended in the air for a long time, enveloping plants in a mist, as



And these birds want to live!

it were. All insects which find themselves in the mist perish.

Chemical insecticides are highly effective. They save vast quantities of agricultural produce. They have also made it possible to control some deadly diseases, such as malaria. Not so long ago, 400 million people contracted malaria each year, and 5 million of them died. The chemical method of controlling the malaria mosquito drastically reduced the incidence of malaria in India.

In the Philippines almost half of the children died of malaria. After a battle was launched against the malaria mosquito in the country, the incidence fell to 3 per cent.

Effective though it may be, chemical warfare against insects has undesirable side-effects.

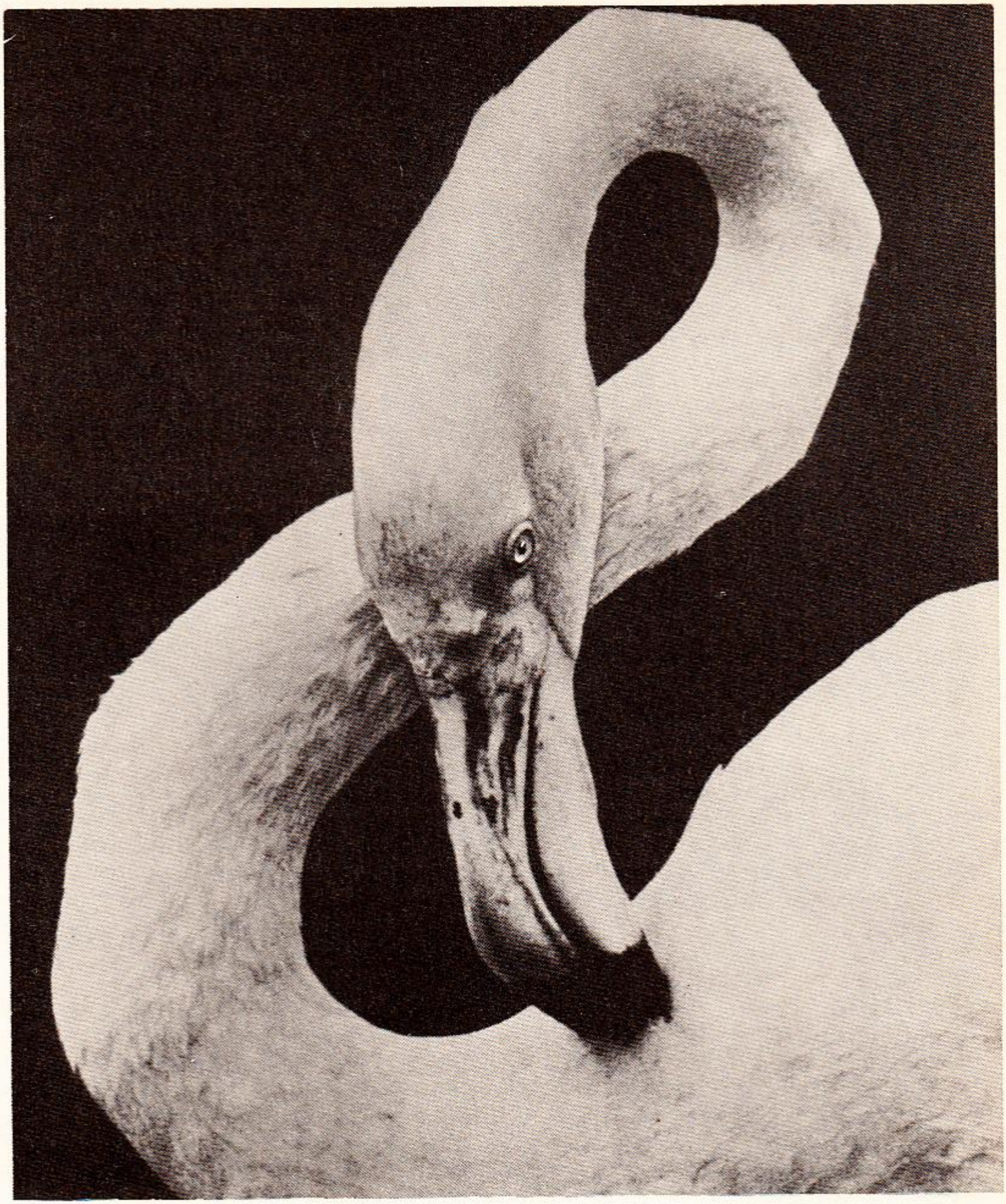
In the first place, useful insects perish along with pests when fields are sprayed with pesticides. Moreover, while useful insects are destroyed totally, tests have shown that a certain percentage of pests always survives. Not many, to be sure, but they multiply at a terrifying rate.

Second, poisons can only be used at a certain stage in the plants' development; otherwise the plants themselves would be harmed and destroyed.

Third, some insects are not affected by any poisons whatsoever. Such are the various *Diaspididae* which are covered with a wax armour protecting them from external poisons, while they are ensured against internal poisoning by the fact that they feed on plants' juices.

Nor do poisons reach insects which live in the soil. And there are quite a few such insects and larvae.

Fourth, many pests which are initially affected by poisons soon develop a tolerance to them. When DDT came into wide use, it seemed that the final



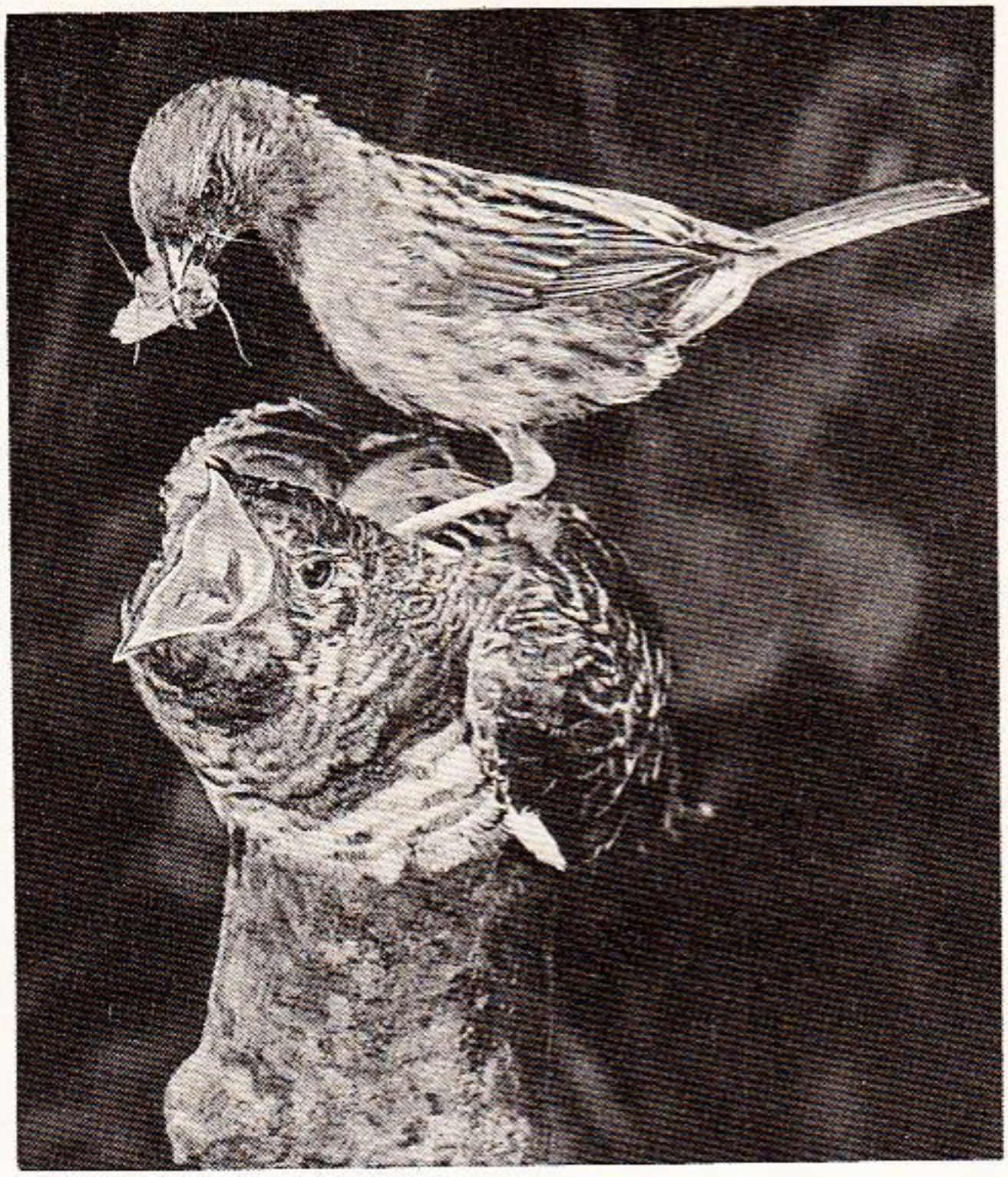
This is not a work of art. This miracle was created by nature.

"An eagle's nest".
An engraving by V. Favorsky.

victory had been won. Indeed, in 1946 there were only two species of insects which were immune to DDT. A year later, however, the housefly developed an immunity, followed by gnats, and three years later, malaria mosquitoes were no longer affected by it. Ten years later, in 1956, 40 species of insects had become immune to the poison.

This fact makes it necessary to develop ever new chemicals. But insects outstrip the chemists. Today there are many species of insects impervious to all poisons. Half of these are destructive agricultural pests, while the other half are carriers of dangerous diseases.

They are discussing something. What? Perhaps people who are so often unfair to animals.



Things are hard for the adopted parents of a cuckoo fledgeling. But they will never abandon him.

Fifth, it has been observed that when one kind of insects are killed by pesticides, mass multiplication of other kinds unaffected by the poison occurs. For instance, when the Colorado potato beetle was suppressed in Poland in 1956-1957, bean aphids multiplied in unprecedented quantities. In America, it has been established that one of the most noxious citrus pests becomes more numerous than ever precisely after the plants have been treated with pesticides.

And, last but not least, poisons are not selective: they affect other living creatures as well as insects.

Danger signals began to arrive amidst general rejoicing about the victory over pests. In one American state, 97 per cent of all birds were destroyed as the result of a campaign against harmful ants. In another state, 80 per cent of birds and small animals fell victim to DDT. In 1960, in the county of Lincolnshire in Great Britain alone, 10 thousand birds were killed by pesticides.

And not birds alone suffer. Fish die by the million, and large animals are affected as well. Of course, mass deaths are rare and only occur when rules of dosaging or application of pesticides are violated. However, when it was decided to check the effect of pesticides on animals in the state of California where

A Himalayan bear.

He is called "a ghost of the dead". In actual fact the lori is a meek and harmless animal.

no undue cause for alarm had so far been observed, it was established that in 1954 pesticides killed 922 partridges, 331 pigeons, 89 hares, 52 pheasants, 10 ducks, 5 cats, 5 squirrels, one fox and one horse. Nobody, naturally enough, wanted to kill them, just as nobody desired the deaths of so many birds in other countries. It might seem that the tiny doses of poison which are deadly to insects could be taken in stride by larger creatures, even if a bird, say, happened to eat the poisoned insect.

But we must remember that a bird eats not one but hundreds and thousands of insects. Poison accumulates in its body until the fatal dose is reached.

When rodents are poisoned, birds of prey die with them. The poison on the surface of plants enters the digestive tracts of hares and squirrels. Finally, the application of poisons, year in year out, causes its concentration in the soil. Thus, the soil of some apple orchards in the United States now contains up to 125 double centners of active DDT per hectare. The 16-17 thousand tons of DDT annually applied in the United States were washed away by rains and spring floods into rivers and lakes, killing fish, waterfowl, and, often as not, all living things.

Moreover, recent studies have shown that in some districts of the United States, accumulated pesticides already present a danger to people.

Very well, one might say, the danger of pesticides has been amply proved. But what are we to do? Stop using them? No, this is impossible. It

The great panda. The animal was discovered in this century. There are very few pandas kept in zoos.

has been estimated that if all chemical warfare against insects were to be discontinued, the Soviet Union alone lose 10 thousand million rubles annually. So pesticides have to be used, but judiciously, with a view to possible consequences and only when there is no substitute.

And it is possible to find substitutes for poisons, to reduce their application, and even forego them altogether.

The thing is that in nature, if man does not interfere too heavy-handedly, pests do not usually multiply in catastrophic numbers.

Take a colony of plant lice on a bush. We know they could swamp the globe. But they never do so because natural forces keep their population down.

There is the caterpillar of the white cabbage butterfly. Since one such butterfly can lay 250 eggs, there could be hordes of these caterpillars around. But mass multiplication of white cabbage butterflies occurs very rarely.

Take, finally, the housefly with its colossal fertility; take the locust or many other insects which, given a free hand, would have long ago destroyed all vegetation and all life on Earth. But this does not happen because all these insects have natural enemies: birds, insectivorous animals, predatory insects and insect parasites which curb their multiplication. Of course, pests do harm in natural conditions as well, and some flare-ups, or mass proliferation, do occur. Still, these are rare and the harm they do is not irreparable.

The fact is that in ploughing up fields and planting orchards man acquired a lot of enemies, but never bothered to win himself any friends. Enemies, as is known, need no cajoling. Take the Colorado beetle. It led an unobtrusive existence in the West of the

United States, and even entomologists knew little about it. It fed on plants which are akin to the common potato. But when man started planting potatoes in those states, the beetle had so much lovely food, it began to multiply in fantastic numbers and became a grave threat to agriculture.

One of the most formidable pests, the beet weevil used to live on weeds and was no concern of man's. But as soon as sugar beet cultivation began, the weevil at once became aware of its superior dietary qualities, moved to sugar beet plantations, and began to multiply at an alarming rate.

At one time, the sunflower was a decorative plant and grew only in gardens. Then it became acknowledged as an important commercial crop and moved into fields. But insects appreciated its merits before man did.

One particular butterfly is known as the enemy of the sunflower. Again, a small and inconspicuous insect of nocturnal habits, known only to a few specialists, it became famous with the spread of sunflower cultivation, receiving a new name in the process — the sunflower moth.

And so it was each and every time. As soon as a new commercial crop appeared, its enemies came to the fore. To be sure, these insects existed before, feeding on weeds or wild plants. But man worked to improve the plant. And the improved plant attracted insects, which lost no time in changing their "specialisation". And they increased in numbers with each year. In the beginning of wheat cultivation, only a very few species of insects used it for food. Nowadays no less than 200 species make their home and dining hall on the plant. The same happened with alfalfa, which today provides nutrition for about 120 species of insects, and maize, which plays host to more than 400 species. No less than 500 species thrive on fruit trees and berry bushes. Nor are these complete figures, for man does not yet know all enemies of cultivated plants, what with new ones appearing all the time.

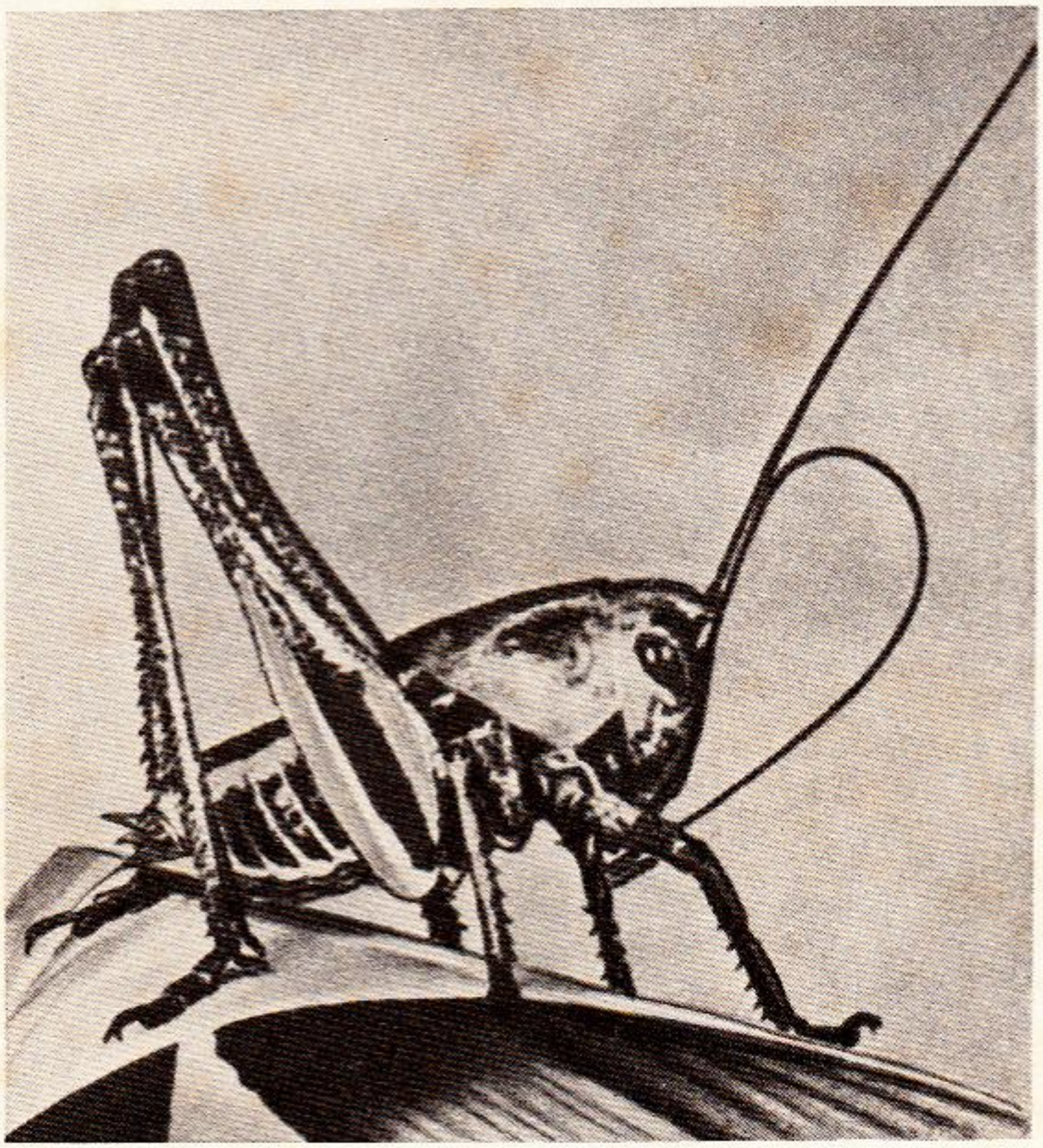
In this way man has made, and is continuing to make countless enemies. He has attracted to his fields and gardens thousands of pests and given them a chance to multiply, at the same time completely forgetting about his friends, which, in wild nature, contain the insect population. And those friends live right beside him. They are hedgehogs and toads, lizards and shrews — small but extremely useful creatures. At best,

And this is a bittern.

man has ignored them and all too often, destroyed them, especially toads or frogs, blithely unaware of their useful properties.

Neither, strangely enough, did man pay enough attention to his chief friends, the birds. Of course, his enemies did not wait to be invited, they invaded his fields and gardens, seizing territory, destroying plants. Friends are much less forward. They have to be wooed, invited, and provided at least tolerable conditions to insure good work.

That birds do good work people have known for ages. But they only became fully aware of its scope when they learnt to estimate the results of this work. Then they realised how criminally stupid they had been when they destroyed birds. To think that not so long ago, 300 million birds were killed by hunters every year! Of course, the figure included all kinds of birds — predators, too — but a large share fell to the small songsters. For instance, the annual turnover of one trader in bird skins in St. Petersburg reached 158,500 skins. Of these 30,000 were sparrows, 1,500 pine-finches, 2,800 starlings, 100 woodpeckers, etc. And this in regard to

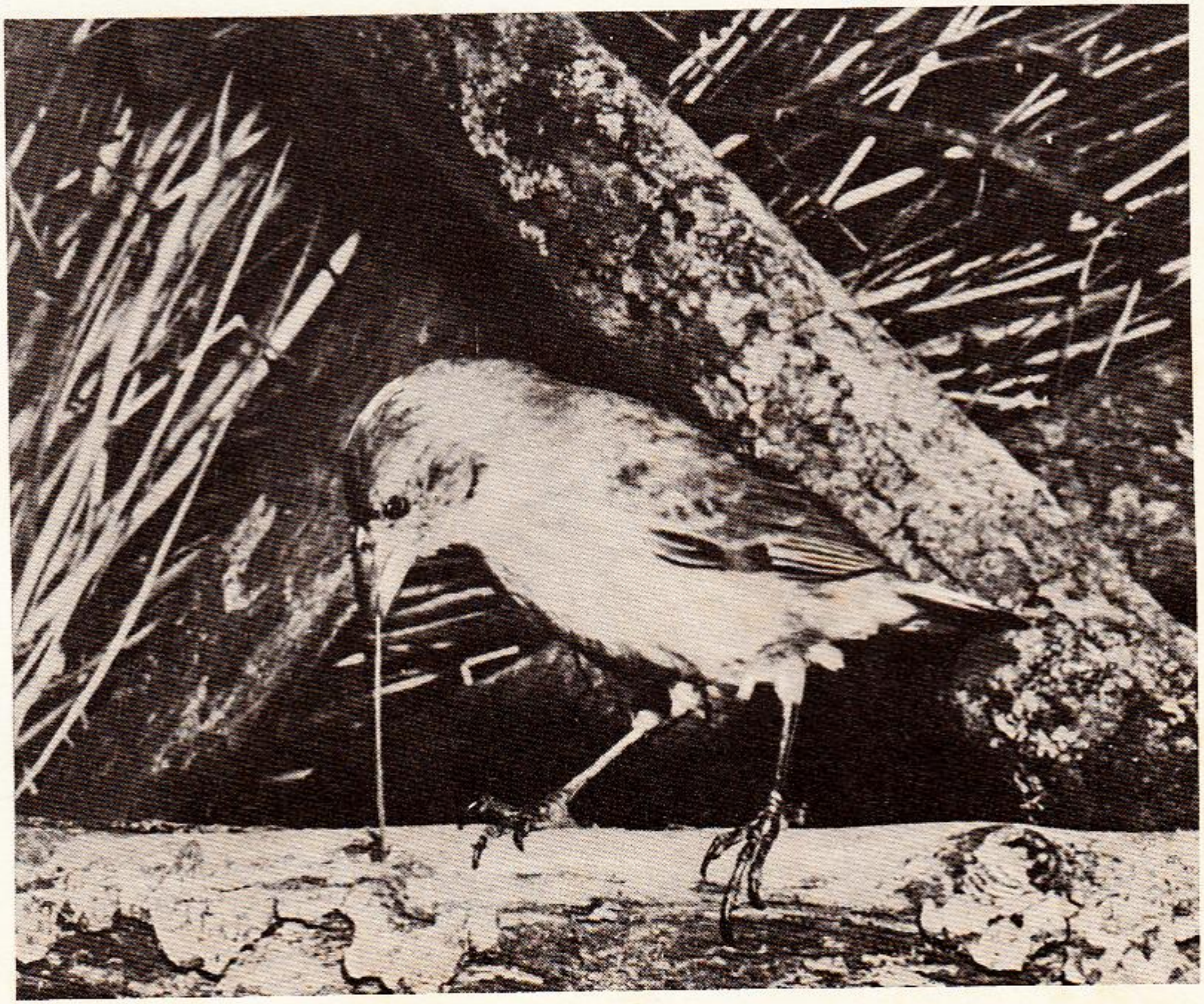


The grasshopper has really remarkable ears.

creatures who deserve a monument for the good they do man and nature.

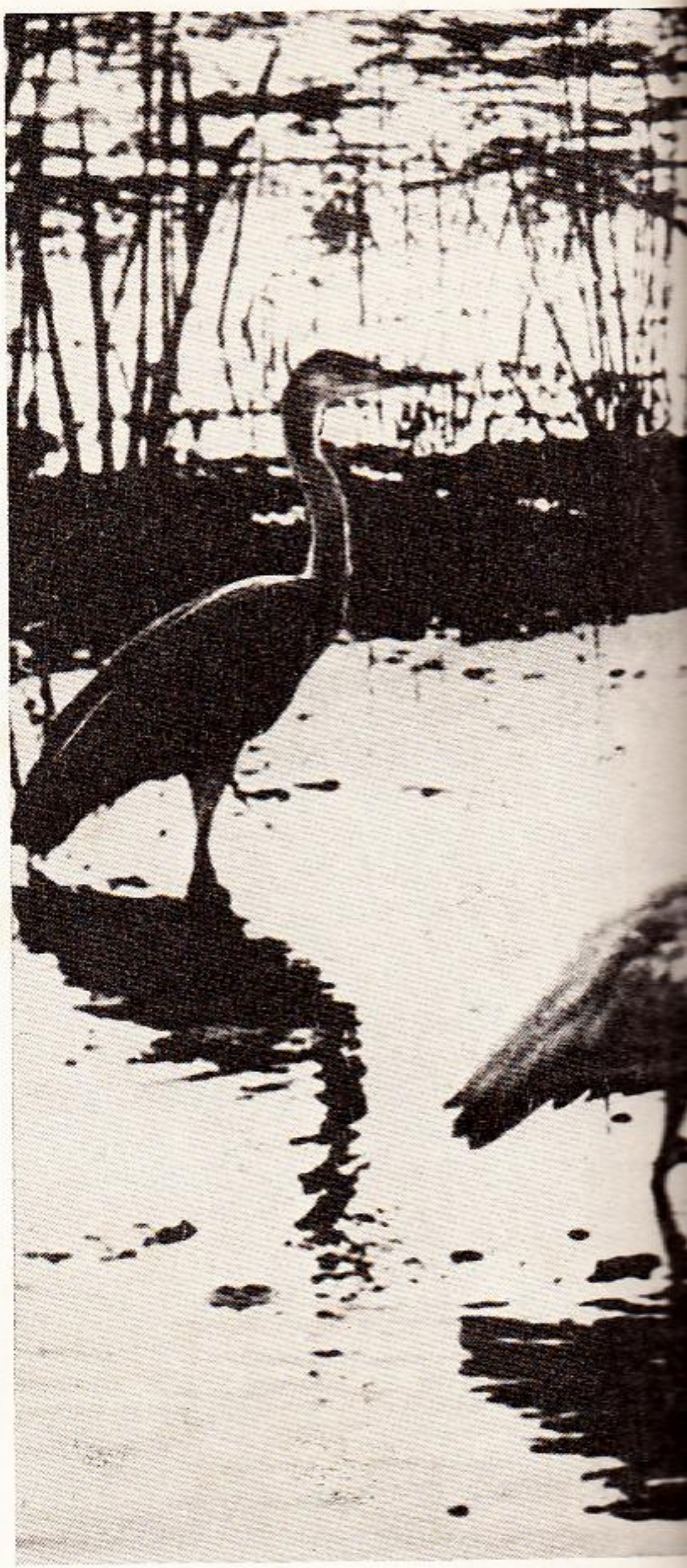
Actually one such monument has been erected — in Salt Lake City. It is a 50-metre tall granite column on top of which is a ball. On the ball are perched two seagulls. At the foot of the column is a pool in which live birds come to bathe. The monument cost the city 40 thousand dollars, but this outlay represents only a small share of the losses the citizenry of Salt Lake City and its environs would have incurred during a locust invasion, if not for the seagulls.

Seagulls are extremely voracious birds. In the course of a day, a seagull eats at least 200 grams of insects, and if we count the fledgelings, the figure rises to 400 grams. That makes about 20 kilograms in 49 days of rearing their young. The 60 thousand seagulls who make their nests in the wild nature sanctuary on the Black Sea coast destroy in a day (*one* day!) 12 tons of insects.



Camarhunchus pallidus is the only bird which uses an "implement" — it picks out insects from chinks with a little twig held in its beak.

The cause of animal protection has been embraced also by stamp-collectors.



The figure for the four summer months reaches 1,470 tons. And this only accounts for the adult birds. We must add to the total the insects they feed their young.

A bird of Central Asia, the rose-coloured starling, destroys enormous numbers of locusts. In Uzbekistan, for instance, during the period when the fledgelings are reared, 10 thousand pairs of starlings destroy more than a hundred tons of locusts.

Smaller birds are not less assiduous. The spotted flycatcher, for instance, catches some 20 thousand insects just to feed its young. And don't forget that the parents have to eat as well. The tiny kinglet destroys about 10 million small insects, their eggs and larvae in a year. A cuckoo can eat several hundred caterpillars in a day. In a word, examples could be cited by the thousand. However, birds often do their good deeds not where we want them to. How are we to attract birds and make them work to man's greatest advantage?

This and similar questions must be tackled scientifically, especially when it is a matter of attracting birds to

These birds are state protected.

large orchards or forests. Observations, experiments and precise calculations must all be drawn upon. Ornithologists have come to grips with this problem only in the last few years, and they have already scored important successes. But much more remains to be done.

Not only ornithologists are seeking ways of combating agricultural pests. Entomologists are looking into the matter as well. There are many predatory insects in nature, such as ladybirds, which feed on plant lice, there are dragonflies, ground beetles, and also parasitic insects which lay their eggs into the bodies of caterpillars or the eggs of pests, thus causing their destruction. Cannot they be induced to "work" more energetically and purposefully, and in those localities where man needs them? People started pondering this question quite some time ago: as early as the beginning of this century the Russian entomologist I. V. Vassiliev brought from beyond the Caspian Sea and let out near Kharkov 12 thousand *Scelionidae*. In the very first year, these insects destroyed more than half the eggs of a very obnoxious pest, the *Eurygaster*. Before the Revolution, invasions of this bug were compared with such natural calamities as earthquakes. Nobody even contemplated fighting the bug, unless we count the appeals for divine intercession made in the fields. Vassiliev and other Russian entomologists proved that the *Eurygaster* could be fought effectively. But nobody gave them any real support, and the experiments of a few enthusiasts never became widespread.

After the Revolution, Soviet entomologists tackled the problem of fighting insects with the help of other insects in earnest.

An insect that has been really "tamed" and is doing very beneficial work is the trichogramma, a tiny creature, some four millimetres in length, which attacks more than 80 species of dangerous pests. Of course, trichogrammas do not actually throw themselves at the turnip or cabbage moth, codling or plum moth — that would be in the nature of a lap-dog attacking a bull. The trichogramma destroys them before they have the chance to hatch. This tiny creature lays its eggs into those of the pests and thus kills the embryo.

Today millions of trichogrammas are hatched artificially and let loose on the turnip moth. Where these insects are "at work", the numbers of these pests are diminished by 60-95 per cent. The trichogramma is just as active against the cabbage moth. To illustrate it with figures, trichogrammas make it possible to save 200-400 kilograms of wheat and 4,200-6,500 kilograms of cabbage per hectare! And if there are almost a million hectares sown in these crops, just try to estimate what the savings would be.

Now the question arises: if the trichogramma copes so capably with these pests, why should man interfere? And another: if the trichogramma is so active, why has it not destroyed all pests by now?

The point is that by itself, that is, without man's help, the trichogramma can be relied upon to destroy not more than 30 per cent of the pests' eggs, and as a rule, the figure is even lower — something like 10 per cent. This is the result of certain features in the trichogramma's development.

It often happens that trichogrammas are ready to lay eggs, but have nowhere to lay them because the pests have not yet appeared or have not reached maturity. Or it may be the other way round:

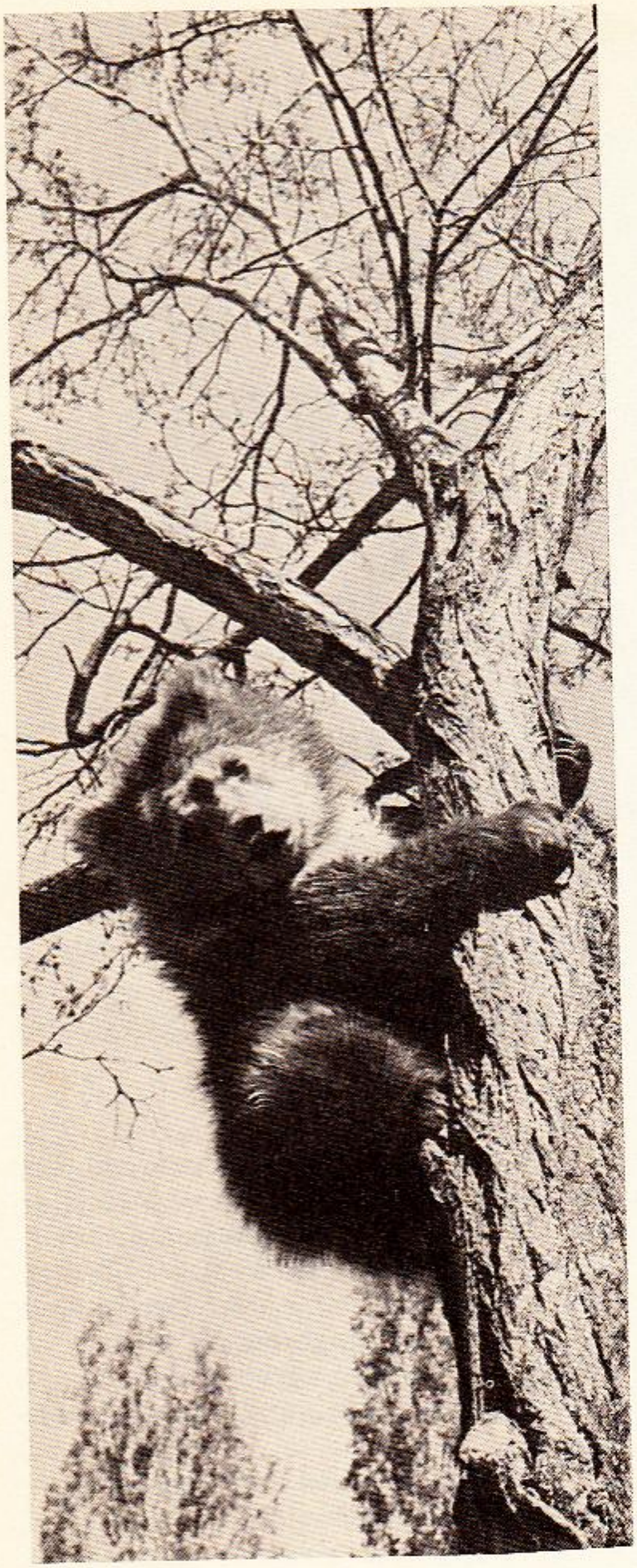
Siberian stags.

the pests are already at their evil deeds, but the trichogrammas are only being hatched.

The trichogramma lays its eggs preferentially into the eggs of the turnip or cabbage moths. And these butterflies do not always obligingly lay their eggs at a time that makes things convenient for the trichogramma. The latter often finds itself in a difficult situation and sometimes fails to lay eggs altogether. That is why man's interference is very important if we want to increase the trichogramma's efficiency.

Of course, trichogrammas can lay their eggs into those of other insects — after all more than 80 species can be its "hosts". And they do just that if they find suitable insects nearby. But if there aren't any, trichogrammas are in a quandary, for their weak wings cannot carry them over any considerable distances.

Man has studied the life of the trichogramma, understood the nature of its problem, and come to its aid. In special laboratories, pests are reared into whose eggs trichogrammas can lay their



An inquisitive bear cub.

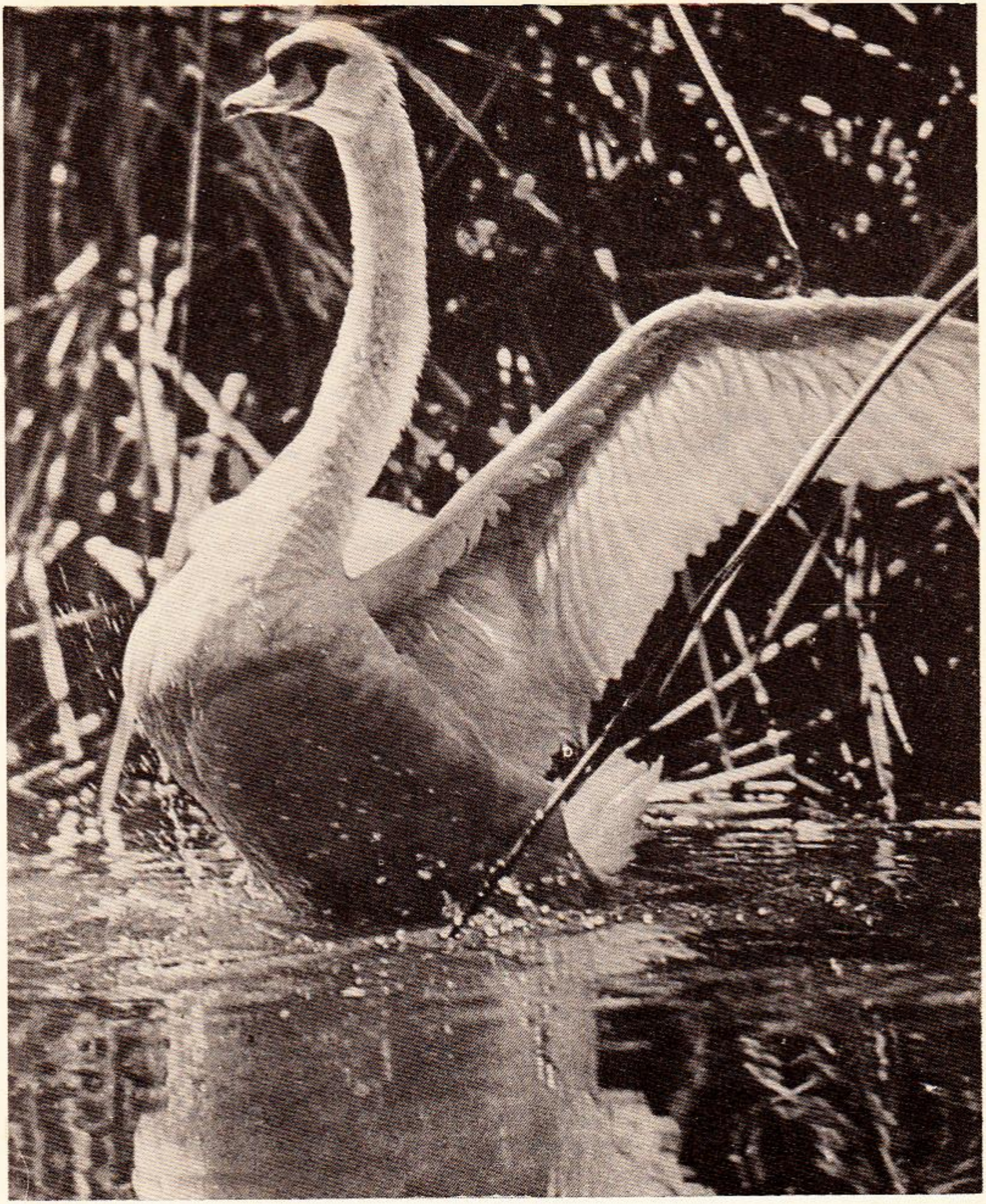
eggs. From these eggs appear infinitesimal, almost invisible baby trichogrammas. They are so small, a good dozen of them will fit on a pin-head. But they are ready for battle and are at once transported to the fields. At the precise time, mind you, when the pests begin to lay their eggs. Of course, to achieve exact timing took a lot of work. Hundreds of experiments had to be made at different temperatures, lighting and humidity, until the desired result was obtained — that is, until trichogrammas began to appear just at the time they were needed.

Still, the trichogramma is not omnipotent. It never tangles with many destructive pests, including the *Eurygaster*. To fight the latter, man uses a tiny insect called telenomus, which is a mere millimetre and a half in length. Like the trichogramma the telenomus lays its eggs into the eggs of pests, 29 species of them, but it prefers the *Eurygaster*.

With man's help, the telenomus has also grown much "stronger", and, hatched in laboratories and released into the fields, it destroys some 70-80 per cent of the pests, thus saving up to 500 kilograms of wheat per hectare.

Thus we can fight turnip and cabbage moths with the help of the trichogramma and the *Eurygaster* with the help of the telenomus. But there are many pests which are still doing their evil work unchecked. Entomologists are seeking their natural enemies. And once these are found, they will begin to "tame" these insects and to enhance those of their activities which are useful to man.

And what about those useful insects which are not grown in laboratories but whose usefulness is undebatable? There is, for instance, a very useful insect called apanteles. It lays its



In the Astrakhan wild nature preserve.

eggs into the caterpillars of white cabbage and roadside butterflies.

But often the apanteles appears ten to twenty days earlier than the caterpillars, and it cannot wait; it must lay its eggs at once. Well, entomologists have now established that the apanteles will not only go on living until the caterpillars appear, but that the number of its eggs will even increase if mustard, colza and other umbellates grow in profusion in the vicinity of the site where it was hatched. It appears that if the apanteles can feed on the nectare of these plants, it can live for a month or six weeks, but if deprived of this food, it dies within a day or two.

There are insects of a different type: they will not lay eggs until melliferous plants grow to maturity in the area.

Then there is yet another problem: many insects are able to lay eggs again some time later, but by then there are no caterpillars to be found. On the other hand, there are plenty of caterpillars in the vicinity. For instance, an insect which has laid eggs into the eggs of the noxious *Eurygaster* some time later can lay eggs again, and if there are no *Eurygaster* eggs available, it can lay its eggs into the eggs of pests living off maize, millet or sunflower.

So plans for varying the plants in any given area must be developed to assure greater efficiency levels for useful insects and, in the final analysis, to protect the plants and increase the harvest.

Biological protection, which is gradually coming to replace many forms of chemical warfare against agricultural pests, is one of the most important problems facing zoology today. It is also a major problem facing mankind. This means not only the saving of millions of tons of grain, vegetables and fruit, it also means the saving of numerous useful animals: birds and fish, mammals and reptiles. It promises clean air, clean water and better health for everyone.

I am sure that the kind, noble, strong and brave people of the future will do everything in their power to ensure the continued existence of the animals still surviving on earth and to preserve nature on our planet.

They will remember with revulsion (if they remember at all) the names of people like Jacques Cartier, who boasted of having clubbed to death a thousand helpless loons in one day, or Abraham Keen, who killed a million seals, or Carmajo Bell, who shot more than 2 thousand African elephants, or William Cody, who killed thousands of bisons.

But they will speak with love and gratitude of Walking Coyote, thanks to whom the bisons survived, Michael Grzimek, who laid down his life in an effort to save animals, Mikhail Zablotsky, Gerald Durrell, Nikolai Podyapolsky, Jan Sztoleman, and many other heroes, sung and unsung, of the great battle for the survival of animals on Earth.

Some day, in the greatest museum dedicated to animals, a place of honour will be assigned to the telegram sent by US President Franklin Delano Roosevelt to the US Secretary for Defence in 1941. The President learned that a firing range was to be set up in a district inhabited by a rare kind of swan. In his telegram, he ordered the army "to look for another nesting ground".

So the military had to make way for the swans, though I am sure many officers and generals were puzzled and indignant. Even today, many people shrug their shoulders when the question of nature protection is raised.

Though the army of animal protectors keeps growing and ever more people come to realise the importance of the task, there are still more than enough people unable to understand what all the bother is about and what use all those animals are. They are probably just as puzzled about the preservation of ancient architectural monuments which could be pulled down to make way for a very useful swimming pool, dancing-hall or cinema; they are probably as sincerely unaware of the value of Raphael's or Rembrandt's immortal paintings.

Architectural monuments and great works of art are mankind's wealth. And so are the animals.

Works of art adorn and enrich life. And man's world would also be a wasteland without flowers and trees, birds and beasts.

Yet there are plenty of people who are quite indifferent to plants and animals and who see no cause for alarm in the extinction of birds or mammals (to say nothing of insects or amphibia).

What practical use is this animal, the indifferent person will ask, what do I lose if it ceases to exist on Earth?

Well, let us discuss the practical aspects of the problem. We know that the Dutch colonists destroyed all the quaggas. It never occurred to them that these animals could be of use to people. Strong and hardy, immune to diseases which decimated the horses brought to Africa, unafraid of the scorching sun, docile and good-tempered, they could easily have been domesticated and would have made excellent draught or riding animals. The splendid naturalist Georges Cuvier was well aware of this in 1821 when he expressed his wonderment that quaggas were being destroyed instead of domesticated.

Steller's cow could have been of even greater use. Man has domesticated only several dozen animals of the great many living on our planet. And not one of these several dozen lives in the water. Steller's cow could have been one. And how easy it would have been to keep it!

Six to nine metres long, Steller's cow weighed some 3-4 tons. According to the testimony of contemporaries, its meat tasted like beef, and that of its young, like veal. Just one grown animal would have yielded 1.5-2 tons of meat. Besides, dozens of litres of milk could have been obtained, and it tasted much like ordinary cow milk. There was also edible fat.

And all this could have been man's with practically no outlay of money or labour, for these animals did not require any fodder, pasturing the year round on the sea shelf. Moreover, like all aquatic animals, Steller's cow apparently grew at a faster rate than land animals. The biggest land animal, the elephant, reaches maturity at the age of forty, and the biggest aquatic animal, the whale, at the age of two. If Steller's cow grew and matured as quickly, this would have been an additional advantage — had man managed to preserve and domesticate the animal.

Other animals, now extinct, could also have been of practical use. Luckily we have saved the saiga. Now we are rewarded with 2.5 thousand tons of excellent meat and a large number of skins annually.

If we manage to save the bisons and ensure their multiplication in sufficient numbers, we would have more tasty meat — a ton from each animal.

Some zoologists believe that in many regions of the world, wild animals could replace domestic ones — fully or in part. They are more resistant to diseases which kill domestic animals, are less particular about their diet, and grow more quickly. For instance, the South African antelope does not fear the tsetse fly, can graze in pastures unfit for domestic cattle and reaches a weight of 320 kilograms in two years.

The same applies to hippopotamuses, the meat of which is not only tastier

but also richer in proteins than beef.

This is all very well, the indifferent person may say, but why should we preserve frogs and lizards — they are not bisons and can't be expected to give any meat.

Charles Darwin once said that if mutton chops were still available in England, it was thanks to old maids. And not because old maids cooked these chops well, but because they were fond of keeping cats. Cats, in their turn, killed mice which destroyed bumble-bee nests. Without bumble-bees, clover wouldn't go to seed for only bumble-bees were capable of pollinating it. And if there were no clover, there would be no sheep, and that means there would be no mutton chops.

This amusing chain built by Darwin is no laughing matter. If just one link is removed, it falls apart. And this is what often happens due to man's thoughtless interference. We often fail to observe the link between different animals, only becoming aware of it after the chain is broken. And as often as not, it is then too late to make amends.

True, we do know quite a bit about toads, lizards, small birds and snakes — not too much but enough to give us cause to stand up for them. We know that they destroy harmful insects and rodents.

But of course there is much more to them. Every day brings new discoveries about animals, even those which are seemingly well known. And there are so many we hardly know anything about. Either about the creatures themselves or about their place in the great ecological chain.

And if we do not protect these animals, if we permit their disappearance from the face of the earth, we may never know how much we have lost.

So animals have not only aesthetic and practical, but also cognitive value.

That is why, while saving and protecting, defending and resettling them, people are constantly studying animals.

For it is impossible to preserve animals without knowing them. And, vice versa, it is impossible to study animals and come to know them without preserving and protecting them.

The more deeply man studies animals, the more remarkable the secrets he unearths, and the more fascinating and complex problems he runs into.

An indifferent and incurious person may again ask: Why should we study them? What's the point of it?

In the first place, in no science, biology in particular, must one use this narrow yardstick and insist on immediate utility. Without accumulation of theoretical knowledge and experience, discoveries are impossible, and so is the progress of science. Secondly, nobody can foretell what practical results today's problem, seemingly lacking in utilitarian importance, may yield tomorrow. Here is one example. The American entomologist G. W. Pierce studied the structure

and functioning of the hearing apparatus of aquatic insects. Anything less useful would be hard to imagine.

But a short time later, the American navy became interested in Pierce's work, for it provided a model for establishing sonic contact between submarines.

Moreover, the study of animals, their body structures and ways of life suggest methods of guiding many important processes in nature — guiding them cautiously and judiciously, without disrupting the ecological balance.

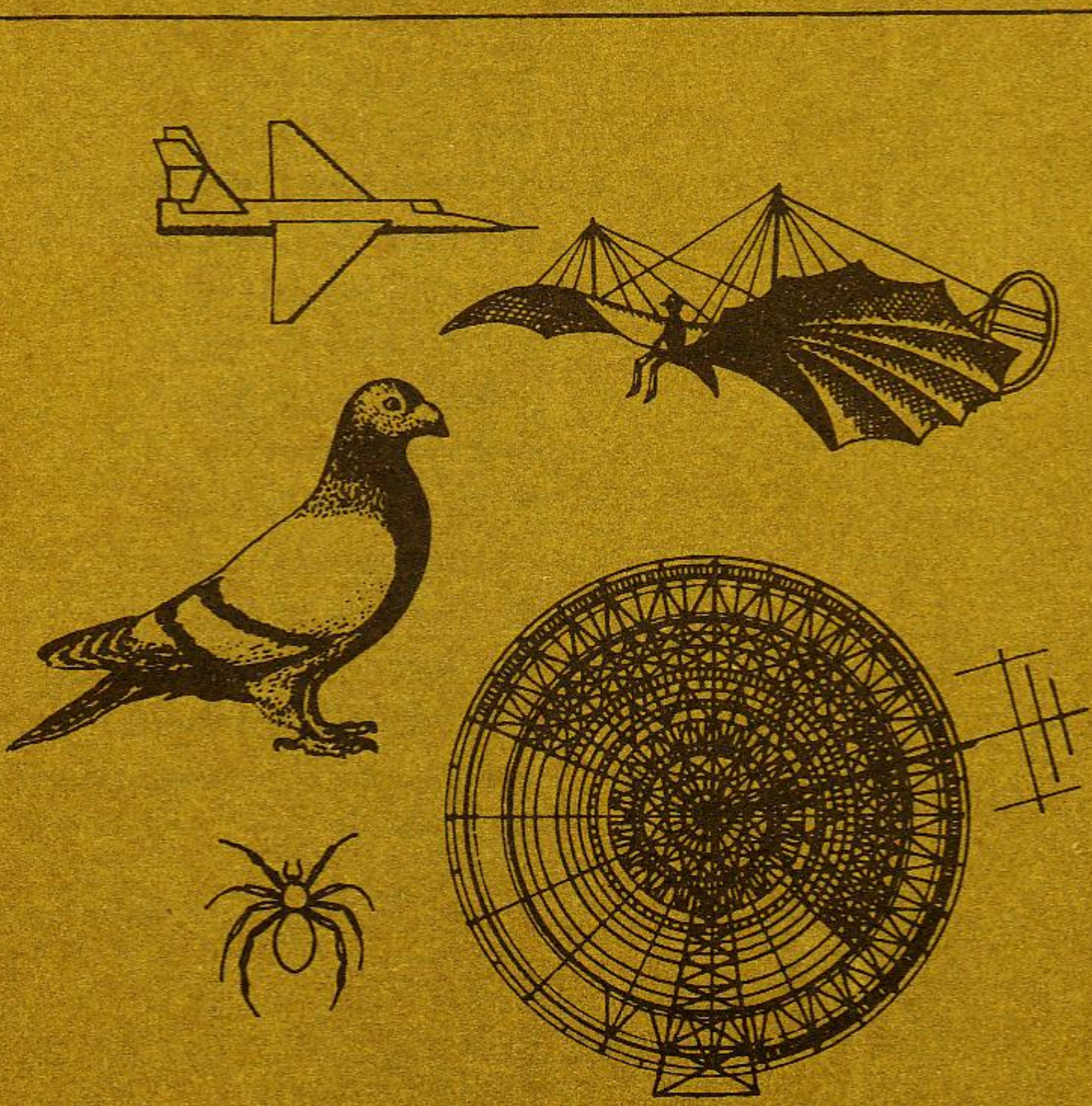
And finally, nature is always a source of ideas for technology.

NATURE EXCITES AND
ATTRACTS INQUISITIVE MINDS
NOW WITH THE BEAUTY
AND VARIETY OF ITS FORMS,
NOW WITH THEIR GRANDEUR,
NOW WITH THE EXTREME POWER,
MYSTERIOUSNESS,
AND STRICT CONSISTENCY
OF ITS PHENOMENA.
IT IS A WONDERFUL BOOK,
FULL OF PROFOUND MEANING,
WHICH IS OPEN TO ALL OF US
AND WHICH ALL OF US CAN READ,
BUT IT IS ALSO A DARK MINE
WHICH CONCEALS IMMENSE TREASURES
IN ITS DEPTHS.

V. O. Kovalevsky

7

Man Studies and Learns



The Birth of a New Science

On that day, 13 September 1960, 700 radio and electronics engineers, physicists, mathematicians, biologists, chemists and psychologists met in the American city of Deighton for a symposium on an odd theme: "Living Prototypes — the Key to New Technology".

This day is regarded as the official birthday of a new science which was named bionics, the science of designing instruments or systems modelled after living organisms.

The name is symbolic in that living nature has now become the main "supplier" of ideas for technology, cybernetics and electronics. It may appear paradoxical, for what could be less related than living things and technology? At best they are indifferent to each other; at worst they are inimical.

Yes, that's the way it used to be. At the dawn of civilization, there were only a few sciences. Before long there were several dozen. New sciences kept branching off from old ones. As mankind studied the world, the atmosphere, outer space, and matter, new phenomena and laws were discovered. By 1960, there were about 1,200 sciences. The reigning queen was of course physics with its many branches. It could not be otherwise in the age of the atom and space flight. Yes, physics had scored great successes largely due to specialisation which made for detailed, scrupulous study. But the deeper researchers in one field of science delved into their own subject, the wider the gap between them and other, even kindred sciences. Life, meantime, made new demands, and biology began to crowd physics out.

Physicists do not resent this, knowing as they do the laws governing phenomena. Major Soviet physicists I. E. Tamm and V. L. Ginsburg declared emphatically that the time was not far off when biology would become the queen of sciences. And the greatest discoveries, such as we cannot even conjecture, would be made at the junction of biology with other sciences. That is why researchers in other sciences are doing joint studies with biologists. We now have such new fields as biochemistry, biophysics, bioelectronics, biological mathematics, medical biology and radiobiology. And in September 1960, an utterly new science, bionics, was born of three parent sciences — biology, mathematics and physics. The coat-of-arms, or symbol, of this science consists of a scalpel (the symbol of biology), the soldering iron (the symbol of physics) and the sign of the integral (the symbol of mathematics) joined together, while the motto of this science is "Living prototypes — the key to new technology".

The emergence of the science of bionics was not, naturally, a chance event: reality had long demanded that different sciences take a closer look at each other and work together. Officially, bionics was born in 1960, but a quarter of a century earlier, the Soviet engineer Ignatiev designed a self-sharpening cutter, the idea of which had been suggested to him by beavers felling trees. Now many metal-cutting lathes use such beaver-type cutters based on the principle devised by nature for the beaver incisor.

If we delve deeper into history, even very distant history, we shall find that man has always learned from animals, imitating and copying them.

For instance, thanks to animals man discovered many medicinal herbs. The valerian root, for instance, was discovered thanks to the cat. The herb is popularly known as "catnip". According to legend, the Greek herdsman Chiron, while looking after his sheep, discovered the medicinal properties of the centaury and began to use this herb to treat wounds. Observation of animals, such as foxes and badgers, who take their cubs out of their burrows and place them in the sun, even in early spring, suggested to Danish physician Niels Finsen the idea of treating many diseases with sunbaths. As a matter of fact, mud-baths were also "prompted" to man by animals.

People imitated animals and learnt from them not only in medicine. Archaeologists find tools used by primitive men. Through studying them and comparing with certain animals, palaeontologists have concluded that many stone implements are fashioned after birds' beaks. It is quite probable that primitive man arrived at the idea of making a tool while watching birds pecking at nuts or tree bark. Perhaps he also learnt from birds to build his first huts, imitating their weaving techniques to make the hut waterproof. Birds may have suggested to man the idea of an arrow, while fish taught him to make his boats streamlined and sharp at the bow.

Man learned to weave and to sew. From whom? Perhaps from birds, which sew leaves together to make a nest, and from spiders, which are unequalled weavers.

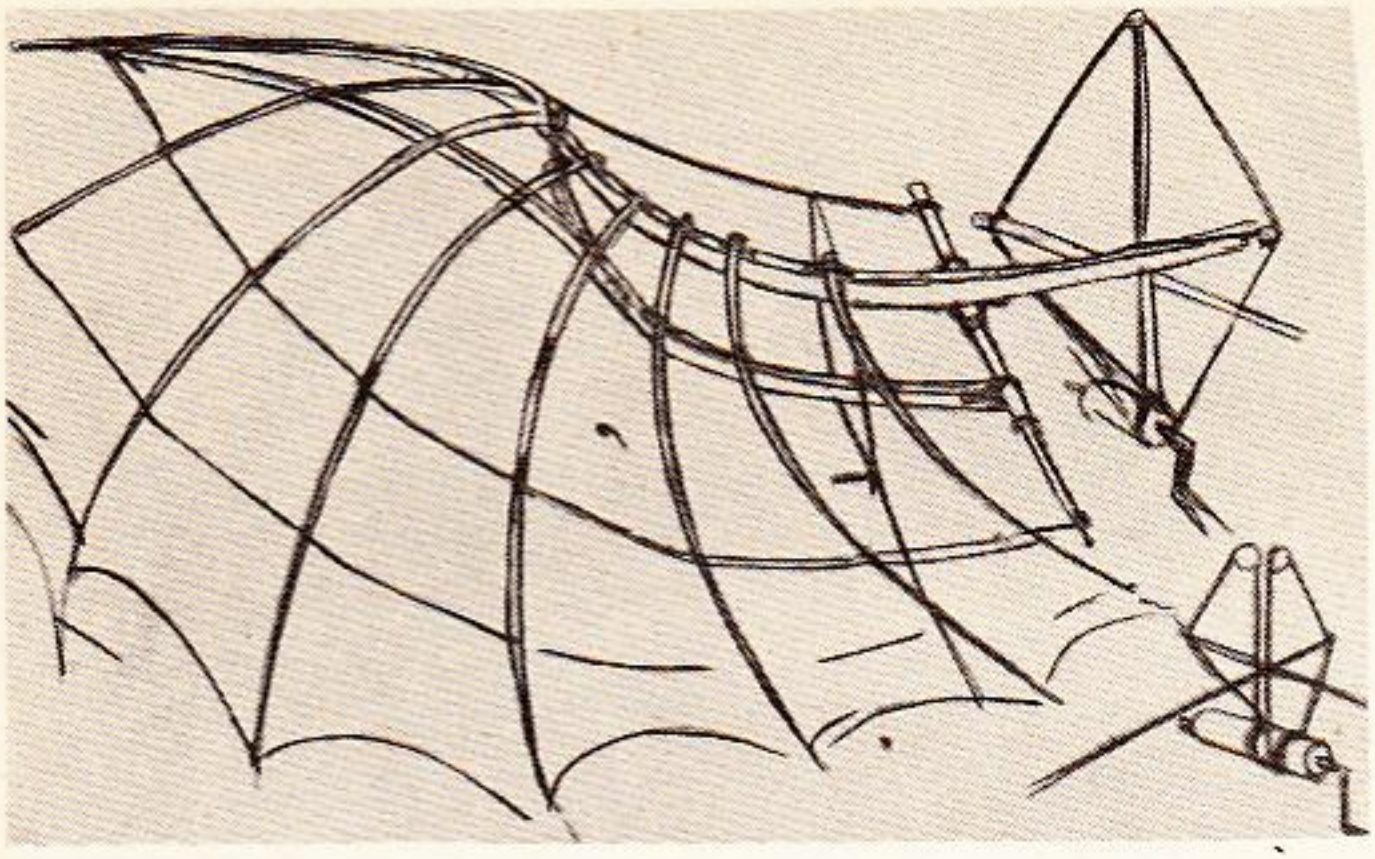
But man got more than practical everyday hints from animals. He dreamed of making wings and flying like a bird. At first these dreams found expression in legends, such as the legend of Icarus, but eventually people began to consider the matter in its practical aspect. More than 500 years ago, Leonardo da Vinci studied the structure of wings of birds, bats and insects with a view to building a flying apparatus.

Several decades later, the "peasant Nikitka, the serf of boyar Lupatov" did manage to become airborne with the help of wings imitating those of birds. Chroniclers have registered quite a few attempts to fly: in 1699 the man named Serov from Ryazan used "pigeon's wings" to rise several metres above the ground. He was followed by others. None, of course, were able to fly like a bird because they did not have the necessary knowledge of the laws of aerodynamics, were unable to make the needed calculations and did not have the requisite materials. All they had was the desire to fly and blind imitation of the birds. People had no notion how complicated the mechanics of a bird's flight was, so complicated in fact, that when, in later years, they studied it in detail, they gave up the idea of flapping wings and built the airplane instead.

Still and all, in old times people did not pay sufficient heed to animals, their abilities and "methods" of doing things. There were many reasons for this, among them the lack of knowledge and opportunity for creative, not simple mechanical imitation, and the lack of communication between the separate sciences.

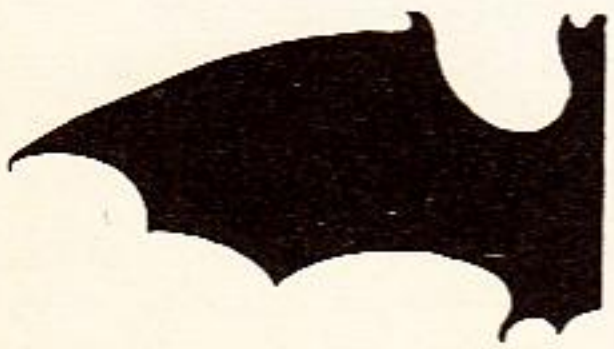
It never occurred to engineers, for instance, who were designing a high-speed airplane to seek the advice of zoologists in the matter of combatting flutter, the deadly vibration of the wings which affects airplanes at great speeds. As long as the airplanes flew at mod-

The fox has such a sly glance as though it knows some secret which it will never tell the people. Perhaps it really does?



Man has dreamed of flying since long ago. Leonardo believed that the bird's wing will help man in this and even designed an apparatus with bird-like wings.

erate speeds, the problem did not exist. But as speeds increased, flutter made itself felt, causing the destruction of one model after another and the death of many test pilots. For their part, zoologists had no inkling of the problem plaguing aircraft designers. Had they been asked, they could have told them that phenomena of flutter also occurs with some fast-flying insects, for example dragonflies. But nature gave them antiflutter devices, making the front edge of the wing heavier than the rest. This feature is easily discernible in a dragonfly where a dark chitin bulge can clearly be seen on the front edge of the wing. This anti-flutter mechanism is called the pterostygma or "wing eye".



But are bats' wings any worse?

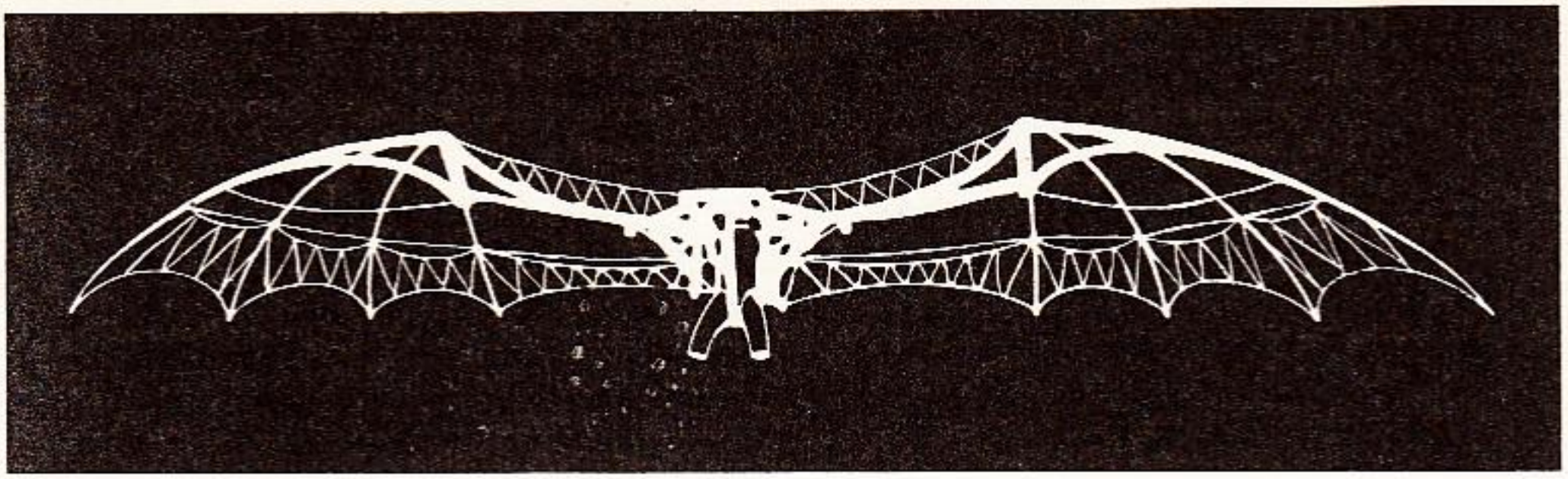
Aircraft designers eventually hit on a method of fighting flutter in airplanes. But many accidents and a lot of brain-racking could have been avoided had they known the structure of the dragonfly's wing.

So we see that, on the one hand, man observed animals, imitated them and learned from them, and on the other, ignored and despised them, considering them primitive and imperfect in comparison to his own creations. But he has been proved wrong time and again, so now engineers seek out biologists hat it hand.

The union of the three sciences is still young, but it boasts many remarkable discoveries already. And there are many more ahead, too amazing to be imagined.

"Soothsayers"

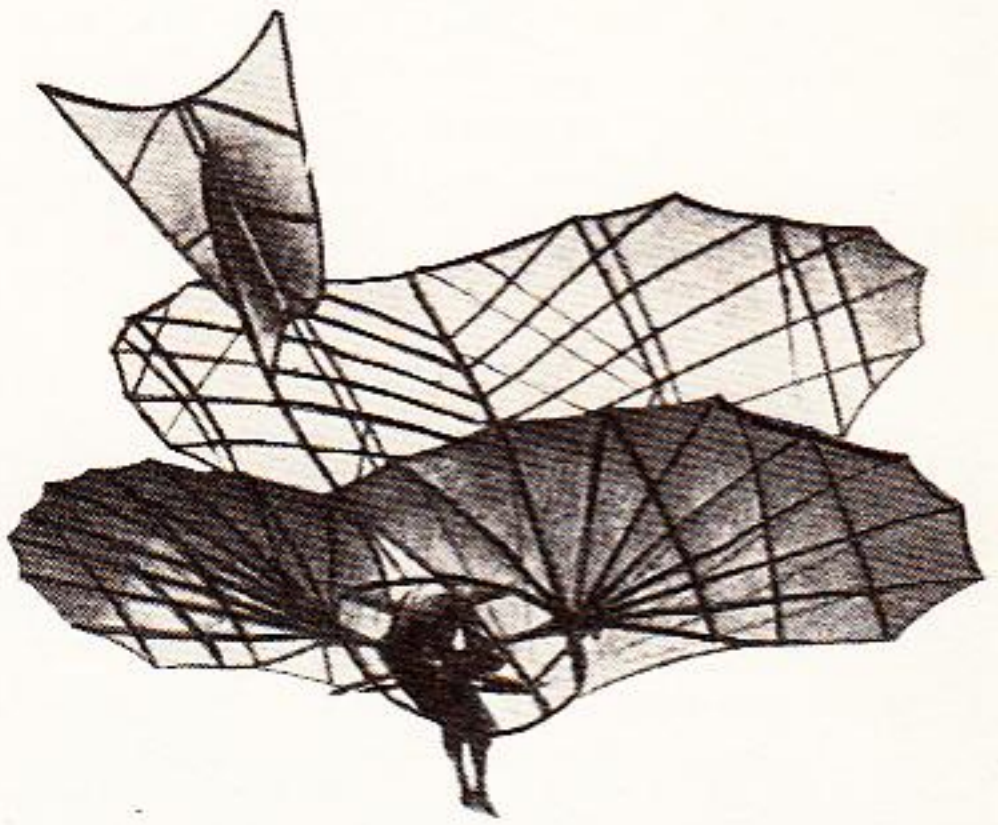
Among the first studies in bionics that were made many centuries before the official birth of this science were observation of animals with a view to



forecasting weather. The question of weather was crucial, for on it depended the harvest and on the harvest depended man's very existence. So numerous folk signs based on the behaviour of animals gradually came to be universally known. Not all are infallible, but quite a few are fairly dependable.

One might ask: who needs signs when we have a special weather forecasting service today armed with reliable instruments and methods?

Of course, we have a weather forecasting service employing many thousands of people the world over. In the Soviet Union alone, there are thousands of meteorological stations with hundreds of meteorological probes sent up into the atmosphere daily, with radiowaves sounding the sky and with artificial satellites carrying out weather observations on a global scale. Similar work is done by all other countries. But despite all this effort, for various reasons, some 15-20 per cent of the weather forecasts prove erroneous. On the other hand, the loach, a fish, proves wrong in only 3 or 4 cases out of a hundred! If the loach are lying quietly on the bottom of the river, one may rest assured that fair weather will hold. If the fish start dashing about, expect rain. In China, peasants keep these



Some designers believed that wings like these will lift man into the sky.

fish in jars specially for the purpose of weather forecasting. They were once kept in Russia to act as a live barometer. When the loach, or a sheat-fish or some other fish, appear on the surface of the water, it is a sure indication that weather is going to turn within twenty-four hours.

In Japan, barometer-fish are recognised almost officially. Aquariums with handsome little fish are to be found in many offices, on ships, and in airports.

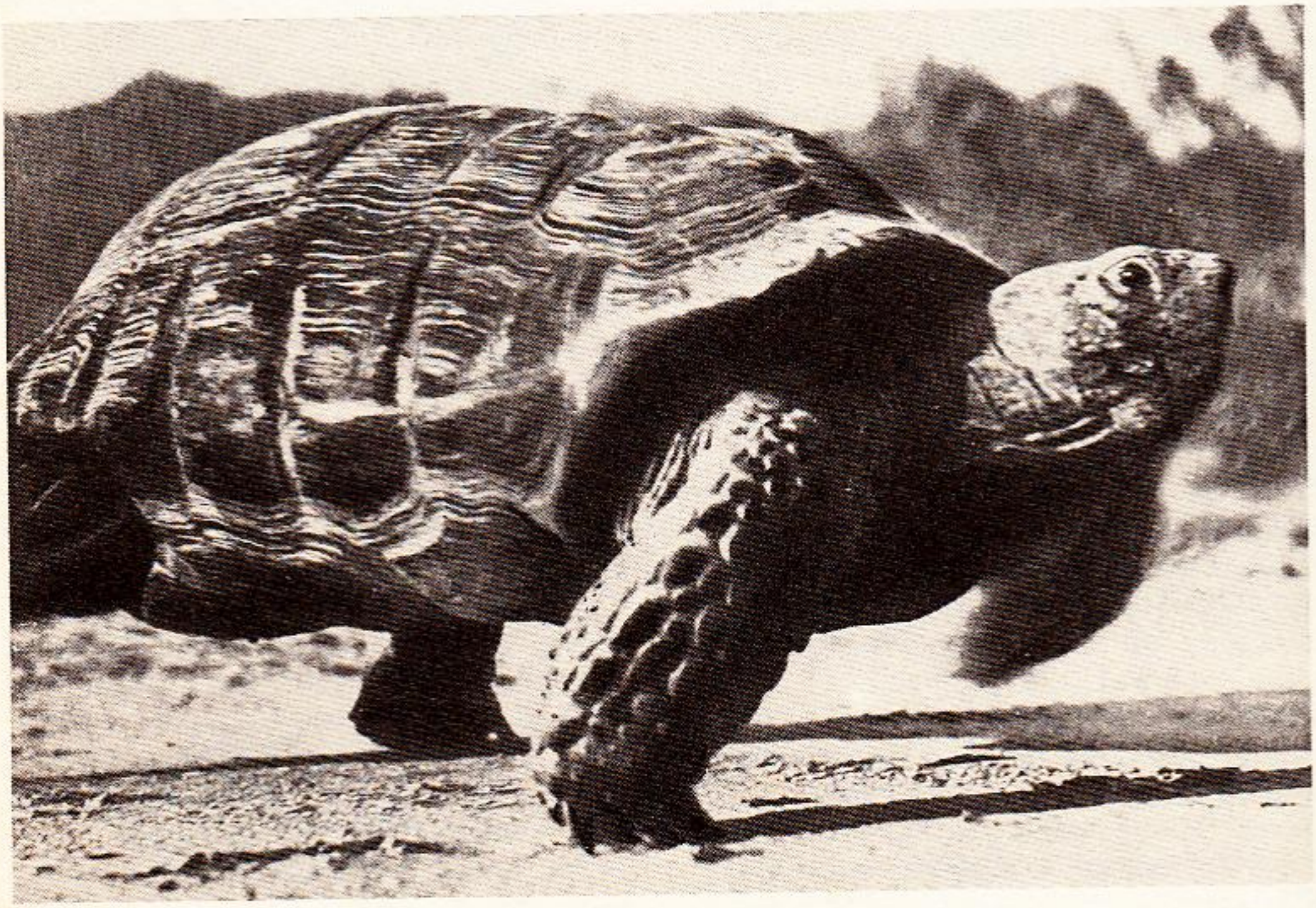
The forecasts of these fish are implicitly believed in by peasants, pilots, fishermen and captains alike. Nor is their trust misplaced — the fish have never yet been known to make an incorrect forecast. The reason for their trustworthiness, ichthyologists have established, has to do with the great sensitivity of their swimming-bladder, which responds to the slightest changes in atmospheric pressure.

Man regards these fish with envy, for he has yet to build a barometer with such a high degree of dependability, one, moreover, that will respond to slow changes in atmospheric pressure to enable him to make reliable long-term forecasts.

Engineers are trying to devise a "fish-type" barometer, but this will probably be superceded by one modelled after insects, for all insects have a forecasting system. Butterflies, for instance, would have long been destroyed by rain did not their warning device prompt them to seek shelter in good time.

And beetles, too. The dung-beetle is universally recognised as a reliable barometer. If it is flying about, you may rely on good weather. If it has hidden, rain is in the offing.

Leeches become restless in expectation of rain, while earthworms crawl up to the surface. Spiders are also very sensitive to weather changes, hiding before rainy weather, while bees keep in



What could the clumsy tortoise teach man, one would think? But what about its test? Why is it so strong? Could the tortoise be persuaded to share its secret with people?

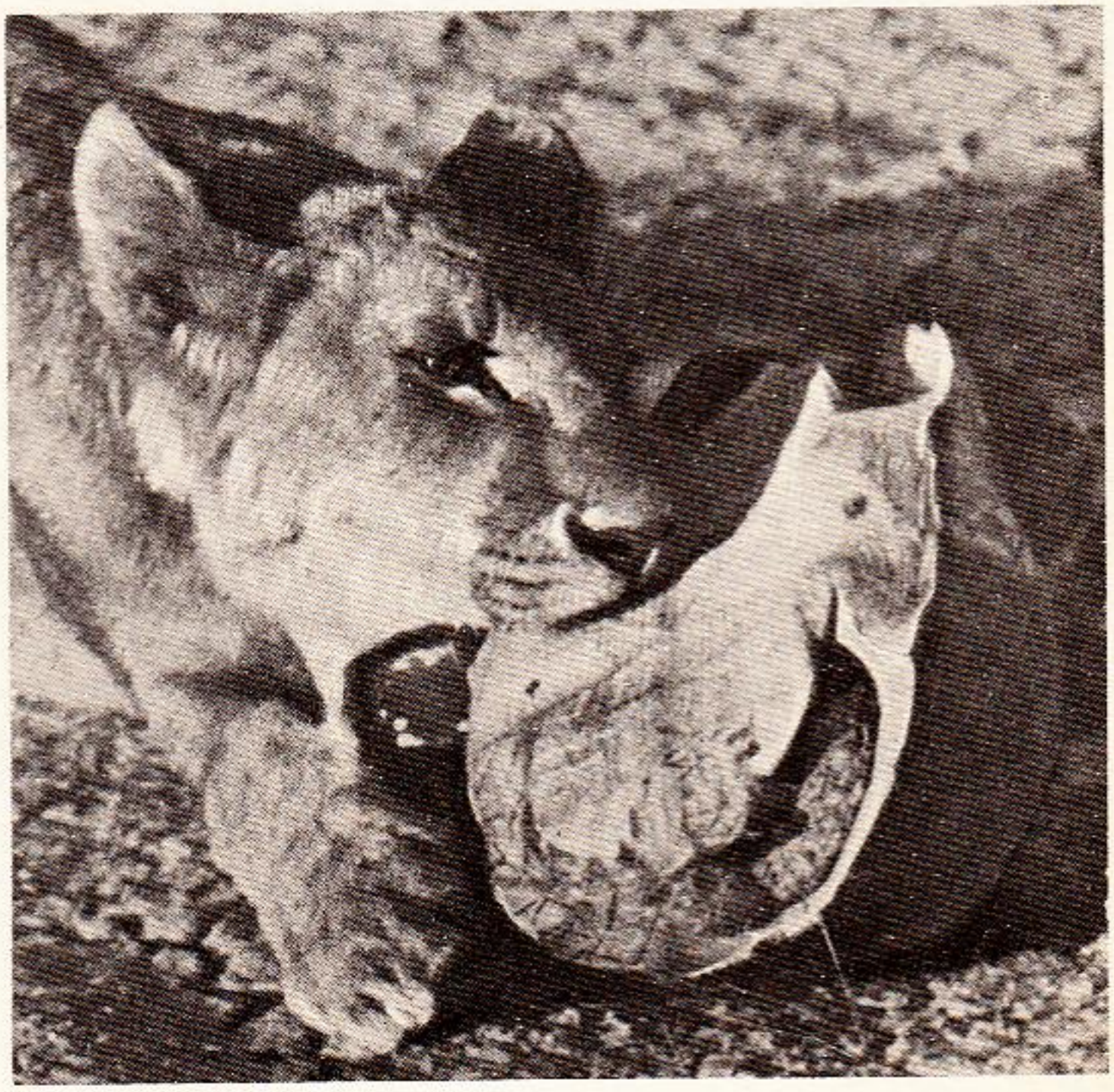
the vicinity of the hive when rain is imminent and "do overtime", going out for nectar far into the evening if a long stretch of bad weather is expected.

We know a great many insects and spiders which are sensitive to weather changes. But how do they "find out" about them? People have established that insects react to changes in atmospheric pressure. That means they have some organ, some barometer-type "apparatus" in their bodies.

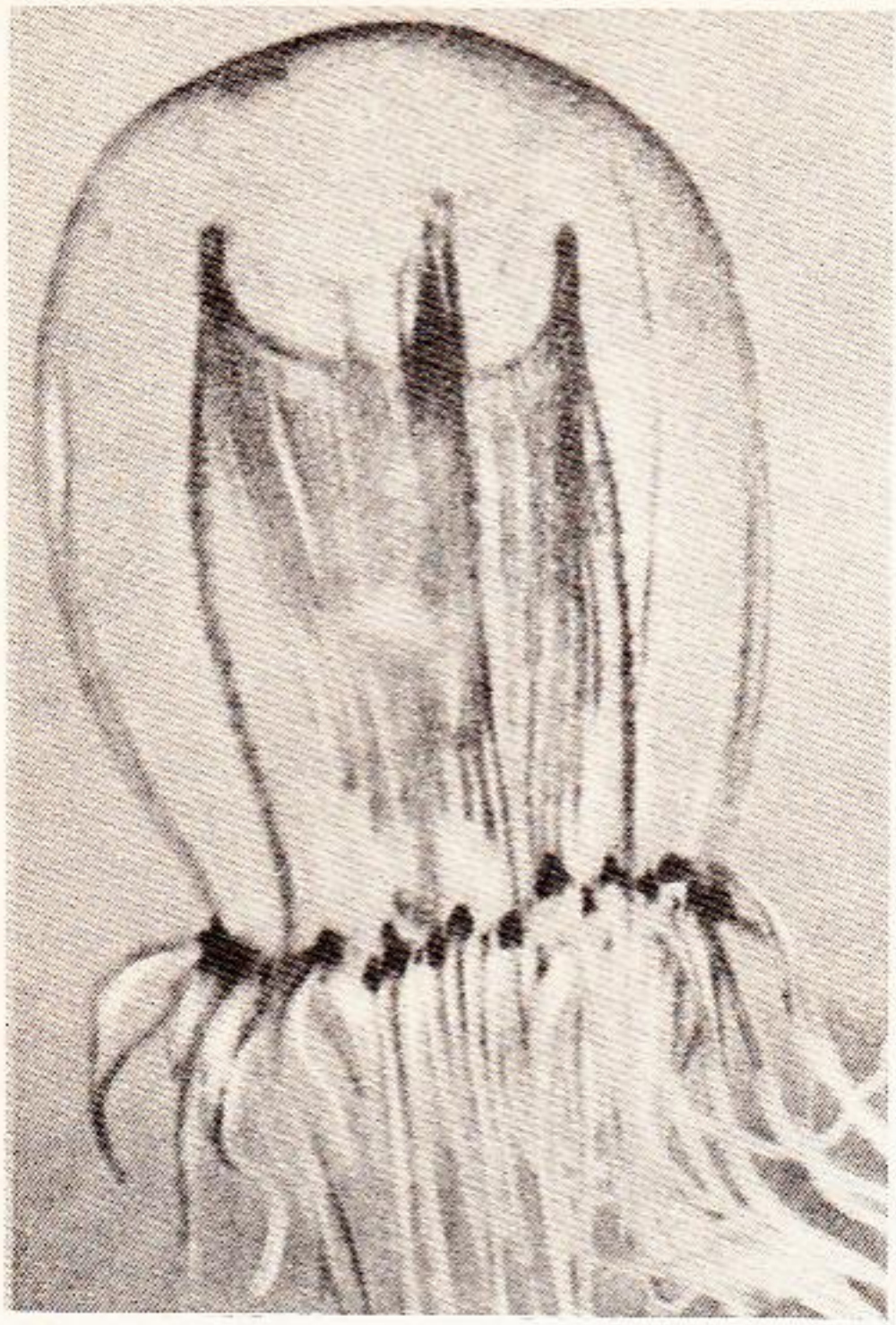
We have yet to discover this barometer in spiders and butterflies, but we have already found it in wood-lice. It consists of tiny protuberances covered with a thin membrane. Wood-lice have more than a hundred of them, and they are mostly situated at the base of their legs. The membrane is sensitive to the slightest changes in atmospheric pressure, and this information is transmitted through the nerve endings in the protuberances to the insect. In this way, the wood-louse becomes "aware" of an impending weather change. The same apparatus is found in some beetles.

It is believed that animals may serve as models not only for supersensitive barometers but also for a device that could forecast such natural calamities as earthquakes.

These is no way we can avert earthquakes. But it is hoped that soon, a method of forecasting them will be evolved. Many scientists are working on



Even the lion's sharp fangs cannot harm a tortoise.



The jelly-fish has already divulged its secret, enabling people to design a storm warning device.

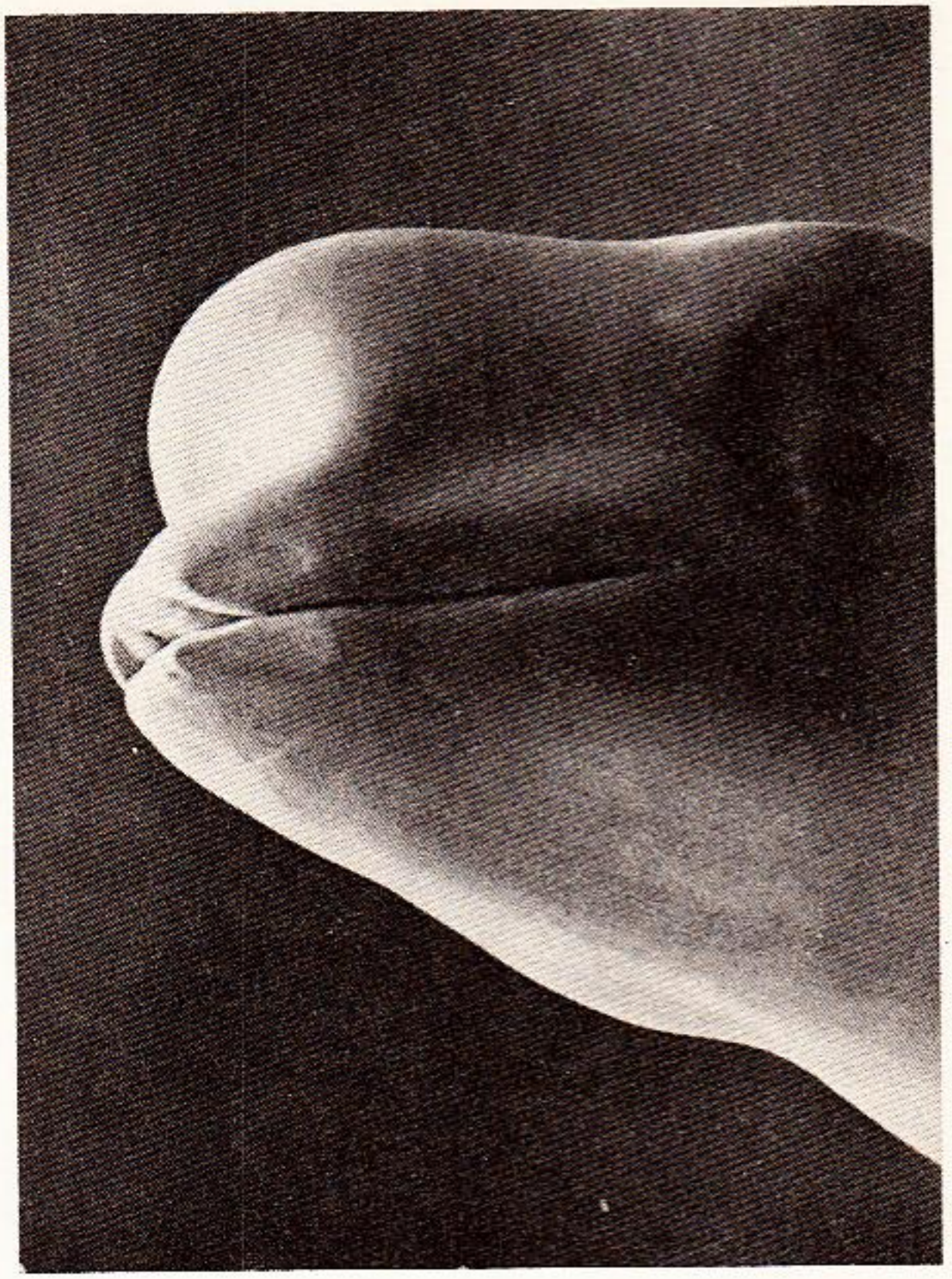
it, for the loss of life caused by earthquakes is terrible. The earthquake which occurred in Turkey in 1967 caused the death or maiming of 2,000 people in the town of Varto alone. And the total count of dead and wounded as the result of a hundred shocks, each 8 points strong in the Richter scale, was 12 thousand. In 1966, the earthquake in Tashkent destroyed 2 million square metres of housing. And earthquakes, mind you, occur on the earth at an average of every two and a half hours. Every year, the earth suffers 20 catastrophic earthquakes, two or three of them in populated areas, 19 thousand earthquakes of which people become aware, and several million earthquakes that are only registered by instruments. According to UNESCO data, more than 14 thousand people die annually as a result of earthquakes.

Yes, an earthquake is a terrible calamity which cannot be averted. But can it be forecast? We now know that the accumulation of an earthquake's destructive energy occurs gradually in the depths of the earth's crust. This means that we should be able to find out about an impending earthquake and calculate the speed of its emergence. Scientists the world over work on forecasting earthquakes with the help of very precise instruments. Nor do the biologists stand aside. They believe they can make a contribution to the task by conducting observations of animals during earthquakes.

There are hundreds of eyewitness accounts testifying to the animals' ability to sense an approaching earthquake and their tendency to leave the danger zone if possible.

In 1902 a volcanic eruption and earthquake wiped the town of Saint Pierre on the Island of Martinique off the face of the earth. The gas cloud which erupted from the volcano's crater burnt to cinders the entire population of the town, 30 thousand, in the matter of half a minute. But the only animal that perished was a cat which was probably shut up in a house and could not get away from the town in time. All the other animals — dogs, cats, cows and birds, all the snakes and lizards, all the animals large and small — fled the danger zone well in advance.

We know, for example, that two days before the Ashkhabad earthquake of 1948, all the snakes and lizards left their burrows. Several hours before the



Our friend the dolphin. People have found out a thing or two about it. But so many more of the dolphin's secrets remain to be fathomed out.

earthquake which destroyed the city of Skoplje in Yugoslavia in 1963, the inmates of its zoo were seized by a wild panic. We know many more such facts, and they have given Japanese Professor Yasuo Suehiro reason to start a serious study of animal's behaviour on the eve of natural catastrophes. The object of his study was to find out how animals become aware of the impending calamity, to find the organ which registers the smallest vibrations and changes in earth's structure and to try and build an artificial model of it.

In 1967 Soviet scientists succeeded in locating this apparatus of "seismic hearing" in fish.

There is a remarkable insect which is capable of registering an earthquake occurring on the opposite side of the globe. This remarkable creature is the ordinary grasshopper. But scientists do not consider it ordinary. In fact, its ear is quite extraordinary, and one day it may help them design a supersensitive apparatus to warn people about an impending disaster many days in advance.

Just imagine how many lives and

how much property could be saved thanks to such a device! It all depends on whether we ever manage to discover the secret of the grasshopper's amazing ear. Let us hope the grasshopper will finally share its secret with people and help them forecast earthquakes, just as the jellyfish gives people advance warning of impending storms and hurricanes at sea.

Like earthquakes, storms take the toll of thousands of lives every year. The most destructive are hurricanes, which, unaccountably, have been given women's names. The best that can be hoped for is that wireless operators who find themselves in the vicinity of one will manage to warn their colleagues elsewhere. But usually, the notice is too short for ships out on the open sea to seek shelter. Nor are barometers of much use: they only gave a two-hour warning. In two hours, even the fastest ship cannot hope to escape the danger zone or reach the safety of a port.

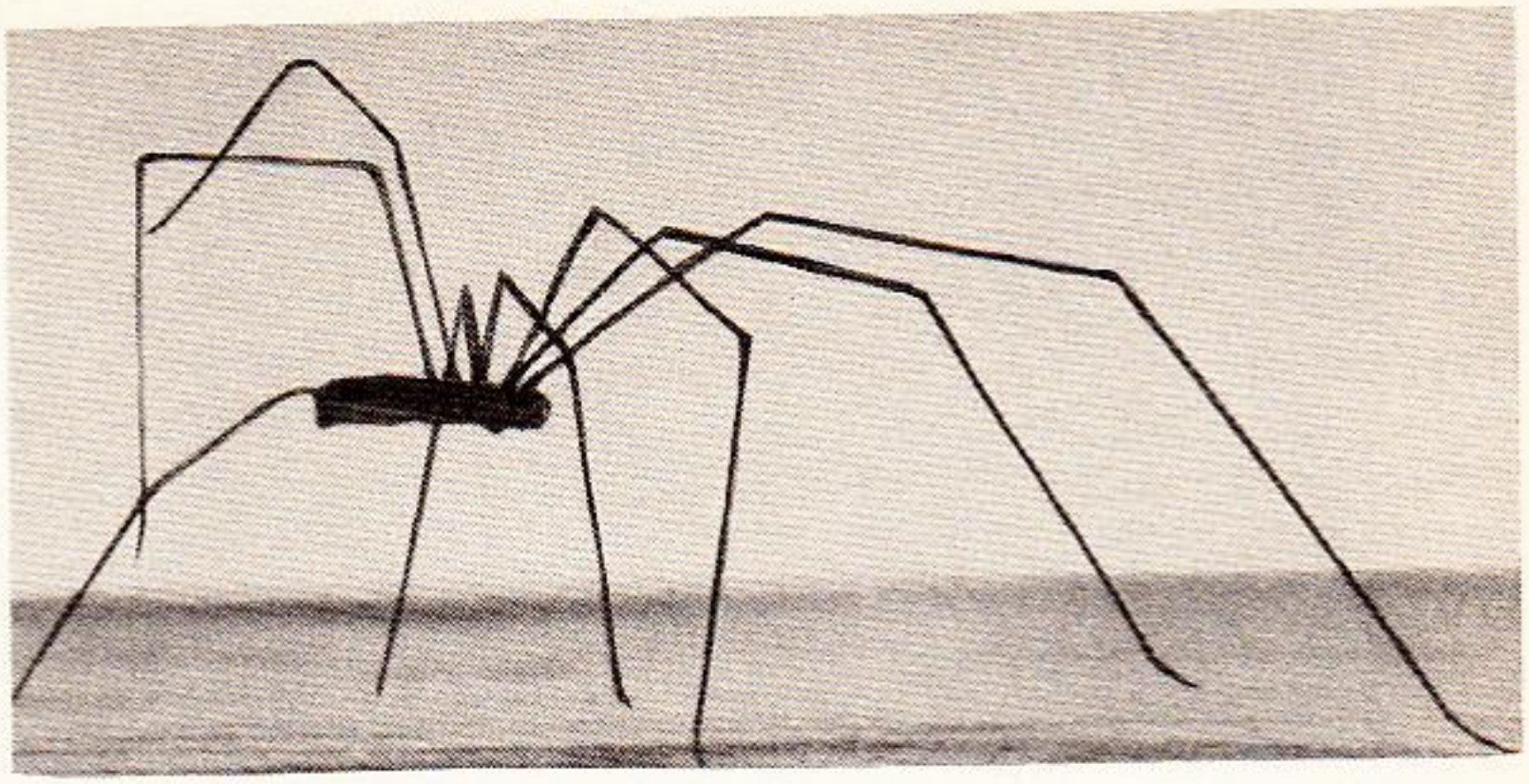
On the other hand, old-time sailors know how to find out about the approaching storm with a much greater safety margin — from the behaviour of birds or small crustaceans which usually crawl and hop at the water's edge but hide at the approach of a storm. Jellyfish also "know" when a storm is coming. Zoologists decided to "interrogate" the latter closely, hoping it would divulge its secret.

And divulge it did. Jellyfish has a special "ear" which registers the tiny vibrations of the water that spread some 10-15 hours in advance of the storm. This organ is like a stalk with a thickening at the end. Tiny "stones" are suspended in this thick part, which looks much like a chemical flask. As soon as the characteristic oscillations of water make themselves felt, the stones begin to move, touching the nerve endings in the wall of the flask and irritating them. Thus the jellyfish receives warning of an approaching storm and hastens to swim into the open sea, lest it be tossed out onto the beach or smashed against the rocks. After a thorough study of the jellyfish's "ear" was made, a longterm sea barometer which warns of an approaching storm 15 hours in advance was devised. The artificial jellyfish ear also indicates the direction of the storm's movement and its strength.

The "Paradox of the Dolphin" and Other Paradoxes

To begin with, the dolphin has always amazed people with its good nature and sociability. Many stories have been told about dolphins saving men at sea, and a large number of them are true. People also told about dolphins which piloted ships out of dangerous waters, and that was often true as well. Later people became interested in the dolphins' "language". Generally, the dolphin became a great favourite with people. Ship passengers and sailors alike delighted in the pranks of these animals and the races they held with ships, which they invariably won, leaving behind the fastest of boats. It was these very races which bore unexpected fruit.

One day, people stopped to wonder how it could be that the dolphin easily outdistanced a ship with powerful engines. It was not so much envy or dismay at a lost competition as surprise. If we remember that water is a liquid with a density 800 times that

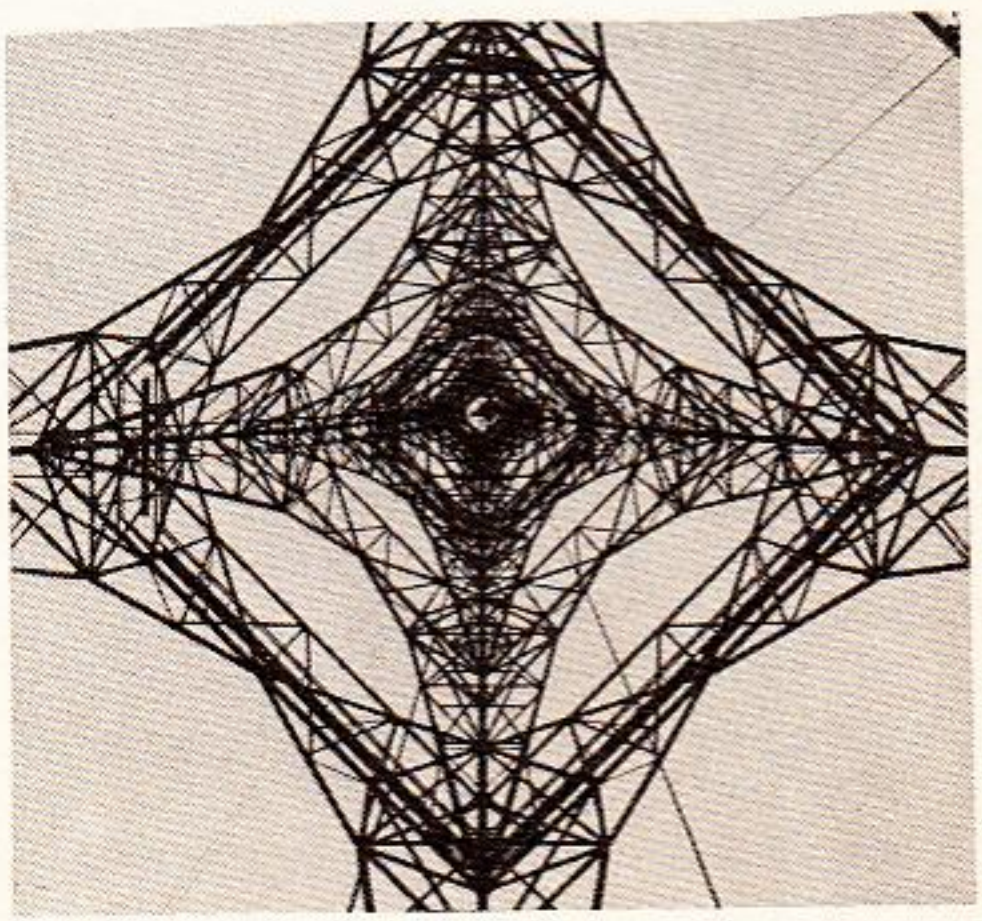


If people could crack the secret of the harvestman's legs, what wonderful apparatus could be built on this principle!

of air and offering strong resistance to a moving object, it emerges that to develop the speed it does, the dolphin's muscles ought to be ten times bigger than they actually are. And not just muscles. Such strenuous work requires intensive oxygen absorption. And look at the dolphin with its middling-strong muscles and even breathing!

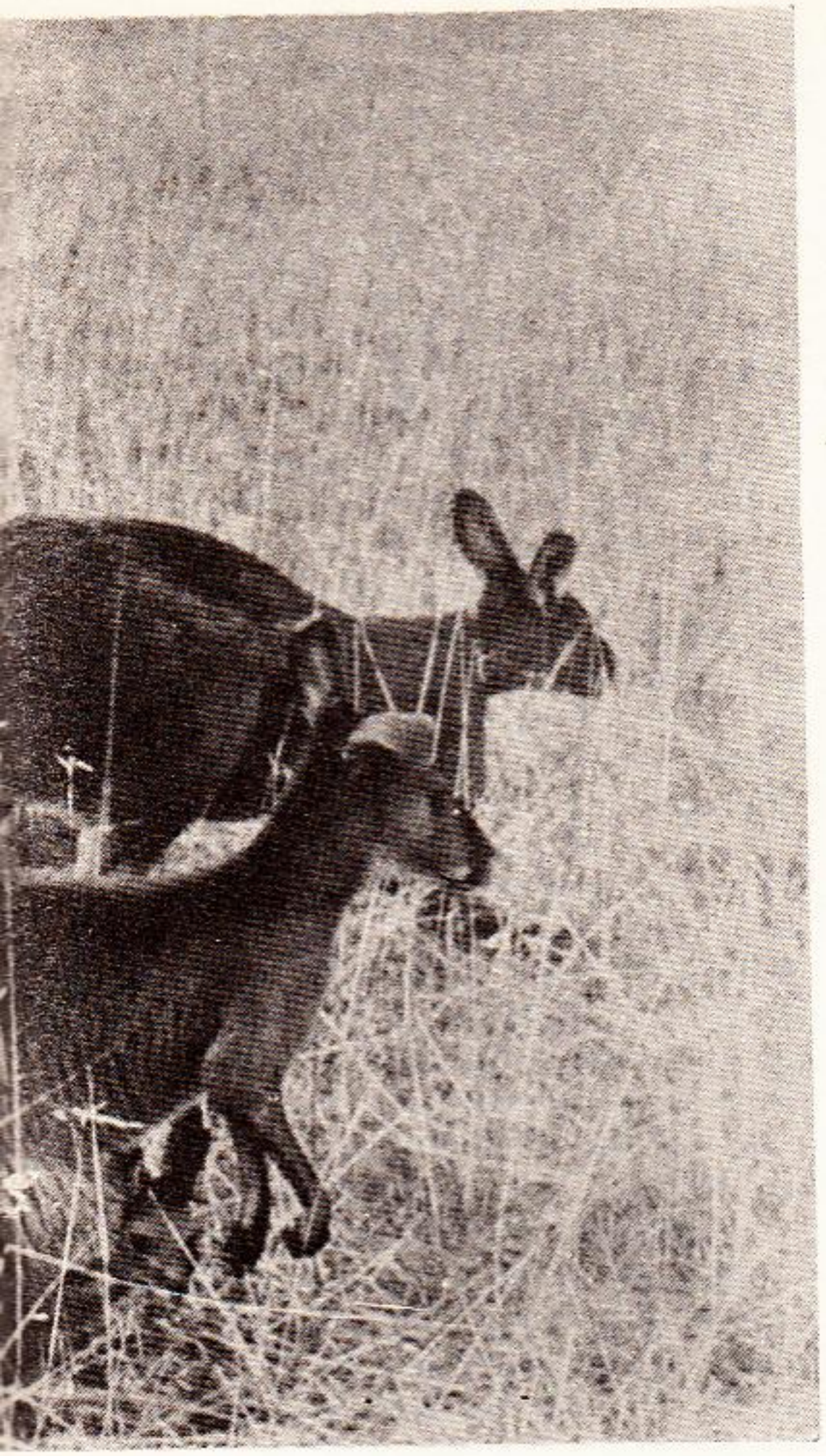
What is at the root of the amazing speeds it achieved with such ease? Can the shape of the body be responsible? After all, didn't the Japanese scientist Takio Inui prove that the shape of the whale's body is much preferable to the one ships are given? Shipbuilders made immediate use of Professor Inui's discovery, and it was found that

The secret of the spider's legs might come in useful to doctors as well as engineers.



Have people borrowed this idea from the spiders?

Kangaroos are splendid jumpers.



a ship imitating the shape of the whale saved 25 per cent on energy carrying the same load as ships of traditional design.

They tried to reproduce the shape of the dolphin exactly, but nothing came of it — the model received 60 per cent more resistance from the water than a dolphin does, although its shape was reproduced down to the minutest detail, and its sides had been polished to a smoother sheen than a dolphin's.

No, obviously it was not a matter of shape. What then? Scientists noticed that a swimming dolphin causes practically no turbulence in the water. Whatever its speed, the water flows around it smoothly. This was not achieved with the model. If it moved slowly, all was well. But as soon as the model (or any other object for that matter) gained speed, turbulence appeared, no matter how smoothly the surface was polished. It is this turbulence that prevents a boat from developing really high speeds.

Again investigations and experiments were launched until people finally understood what enormous advantage the dolphin has over ships.

It is attributable to the animal's skin. A thorough study of the skin revealed that it consists of three layers and has a multitude of cells filled with fat and water; this structure enables the dolphin to break all speed records. Thanks to this soft pliable skin, no turbulence appears around the dolphin, even at very high speeds. These conclusions were tested by the German engineer Gustav Kramer working in the United States. In 1958, he manufactured artificial "dolphin skin". Three model boats were covered with this skin, while the fourth, smoothly polished, was left without a covering for

purposes of comparison. When a motor boat pulled these four models along, the fourth model was immediately troubled by water turbulence, while the other three received half, or even 40 per cent of resistance the fourth model encountered.

It was decided to cover the sides of some launches with artificial "dolphin skin", and the launches dashed ahead at unheard-of speeds.

Of course, much remains to be done. Artificial skin is far inferior to the natural skin of the dolphin; besides the speed of the dolphin's movement is traceable to many other causes as well. Be that as it may, the shroud has been lifted from the dolphin's secret, and the first attempts to build ships according to the dolphin's "patent" have been successful.

The dolphin, however, is not the only champion racer of the submarine world. The swordfish can reach speeds of up to a hundred kilometres an hour. The secret lies in the changeable shape of its tail fin.

Soviet engineer A. A. Usov has performed an experiment modelled after the swordfish: in place of the usual propeller screw he installed a frame with plates attached so they could make vibratory movements and change their overall shape as well. The boat on which the frame was installed could reach double the speed of a similar boat with an ordinary propeller.

The problem of speed and engine power is a crucial one, since sea transportation is constantly growing in volume, necessitating the building of more ships. Economists have calculated, however, that instead of increasing the number of ships, it would be more economical to increase their carrying capacity. And here the lessons of the dolphin and the swordfish would come in handy. We also hope to learn much from the cuttlefish, the octopus, and the squid. Scientists are particularly interested in the squid, which is equipped with a real jet engine. It sucks water into a big muscle bag and then expels it with great force from the back, being propelled forward like a rocket itself. Some specialists consider it capable of developing speeds of up to 150 kilometres an hour. Moreover, at this great speed, it has excellent manoeuvrability, making sharp turns and going steeply up or down. The sucking in and pushing out of water takes mere fractions of a second. When a squid, having attained a high speed, jumps out of the water, it can fly (sometimes at a height of 10 metres above the water) for as long as 50-60 metres.

This excellent engine could not but attract the interest of scientists and engineers. V. S. Dziakevich designed a boat with a water-throwing engine based on the principle of the squid's "jet engine". Pumps suck water into special chambers from which it is pushed out with great force through a nozzle.

Naturally this engine is greatly inferior to the squid's. But it makes it possible to dispense with paddles and the propeller screw and enables a small launch to move along shallow rivers and come close to the shore.

Is there any other way of swimming in shallow waters?

When scientists started pondering this question, they remembered a small insect which skates jauntily over the water's surface. Mind you, it does not swim, it skates on water as one does on ice. This insect is called the water strider and its thin legs are "shod" in special greased hairs that keep it on

the surface of the water. For this insect, the depth of the water is of no importance whatever. If only we could design a ship along these lines! No shallows would hold any dangers for it. So engineers are looking thoughtfully at the water strider.

On the Ground and Beneath It

While the water strider scuttles about on the surface of the river, another creature, also possessed of thin and long legs, rambles along on the shore, attracting even keener interest on the part of engineers. This creature conceals a secret which scientists of many countries have been trying in vain to discover.

This creature is the spider, the ordinary spider we have all known since childhood, about which many tales are told but very little is known to the layman.

In the first place, spiders are excellent weather forecasters, and meteorologists are greatly interested in their "barometers". But of even greater interest are the spider's legs, which fascinate engineers.

There are many kinds of spiders — large and small, dull and brightly coloured, and some that can change their colouring like a chameleon; some move very slowly, others run fast; still others can jump to a height of up to 10 centimetres, even though they are only one centimetre tall. By comparison, if man could jump so high, he would think nothing of leaping over six-storey houses. Just imagine the kind of muscles one needs to execute such jumps!

And the amazing thing is that the spider has no muscles whatsoever. Its legs are hollow tubes through which blood flows. If the blood flows in slowly, the tube-legs unbend slowly. But what if the blood gushes in quickly under great pressure?

When the water hose lying limp beside the road is filled with water under pressure, it straightens up in a second and becomes hard and resilient. Sometimes it is all you can do to hold it. About the same thing happens to a spider's legs. Blood flows into the tube-legs suddenly, they unbend at once, and the spider makes a step or a jump. The next moment, the blood pressure decreases and the spider's leg bends freely. Then the procedure is repeated.

As you can see, people have divined the secret of the spider's stride. But they still do not know how a spider manages to raise and lower its blood pressure at a moment's notice. And they would very much like to find it out, for then they could design a really wonderful striding machine.

A spider has eight legs. Perhaps the machine would have eight legs, too, of perhaps only four, or all of twenty or thirty. The engineers will have to decide that. All kinds of ideas have been put forward, and a many-legged device has a lot of supporters. A many-legged carriage has already been designed in the Soviet Union, and this "centipede" has given a good account of itself, striding easily across ravines and over swamps.

As a matter of fact, the idea of walking machines is not all that new. Back in the 19th century, the Russian inventor P. L. Chebyshev suggested a design for a walking, or as he called it, "foot-stepping" machine. The machine's legs were fashioned after an insect's —

This is the method of locomotion the penguin adopts on land when in danger.

they were an exact replica of a grasshopper's legs.

The spider-car is still in the process of development, but a car "suggested" by penguins already exists.

In the Arctic regions, where there are no roads or even paths, and deep snows spread for hundreds of miles, the only means of transportation is a sled pulled by reindeer or dogs. Powerful cross-country vehicles cannot pass everywhere, and their speeds are low. Neither are aerosleighs usable everywhere, and they cannot carry large-size or heavy loads either.

The need for a machine that could move easily and quickly over snow and carry passengers and freight was urgent indeed.

But what model should it be based

on? What part of nature could be of assistance here?

And then scientists and engineers thought of penguins. Penguins walk on two feet, as everybody knows. Their stride is slow and waddling. They are only fast and nimble in water. But what does a penguin do when it has to make haste while on land — when its life is in danger, for instance? It flops down on its belly and uses its flippers to propel itself along.

"What if we try to imitate the penguin?" thought the engineers.

Designers in the USSR built a vehicle modelled after the penguin. The result was a snow-strider which needs no roads and does not fear blizzards or snow-drifts, and does not sink in powdery snow. The belly of this machine rests on the snow, while wheeled paddles on its sides make it slide along. This is the exact principle of the penguin and the machine is actually called the Penguin.

Scientists and engineers copy living models not only in building machines for land use. Machines to delve into the earth's bowels, where no one but science-fiction writers have yet gazed, are also needed. And for this a special kind of machine will be required. Actually it could be of great use at present. Just think how much time and effort is expended on laying a new telephone cable, changing water pipes or repairing damage to the electrical grid in a big city. Sometimes asphalt in the middle of a square has to be broken up and then laid anew. Wouldn't it be wonderful to have a burrowing machine like one of the many animals which burrow passages underground? How, exactly, do they do it?

Of course, people have pondered the problem and observed insects and their larvae that live underground. So far, it is thought that the most suitable living model is the tiny worm only a centimetre or a centimetre and a half in length which is called priapulida. This worm digs passages in the damp soil at the bottom of the sea. The worm has a strong-muscled body filled with liquid and provided with special appendages to keep its body in place. Propping itself against the soil, the worm contracts

and then straightens its body, pushing its way forward with a proboscis on which are situated a thousand and a half tiny thongs. Then liquid is pumped under pressure from the body into the proboscis and the latter fills out and widens the passage. The worm, moreover, turns the proboscis at an angle, widening the passage still more. Next it pulls its body forward and retracts the proboscis at the same time. Having made itself fast in the new position, the priapulida pushes out its bore-proboscis again, makes a fine burrow, widens it out, and so on.

The boring methods of the priapulida deserve the closest attention. On the other hand, is not the mole of equal interest as a burrowing model of an underground machine? Yes, and as a matter of fact, "iron moles" have already been designed and tested.

There are also some other animals which will probably be "consulted" by designers of digging and drifting machines. It is much more difficult to choose a model for a flying machine. After all, a third of all animals living on Earth can fly. Whom should we imitate?

"Birds! Who else?" some will say.

"And why not insects?" others will inquire.

Birds or Insects?

If man seeks to perfect his means of conveyance on land and water and underground and under water and even over snow, why not try and perfect his aircraft?

This may seem strange to some. Isn't it precisely in aircraft building that enormous progress has been made in a very short time? A mere several decades ago, he only dreamed of lifting himself off the earth, and today he is already flying at supersonic speeds!

But man is never content with his achievements and forever strives for more. Every day he comes to grips with new technological problems.

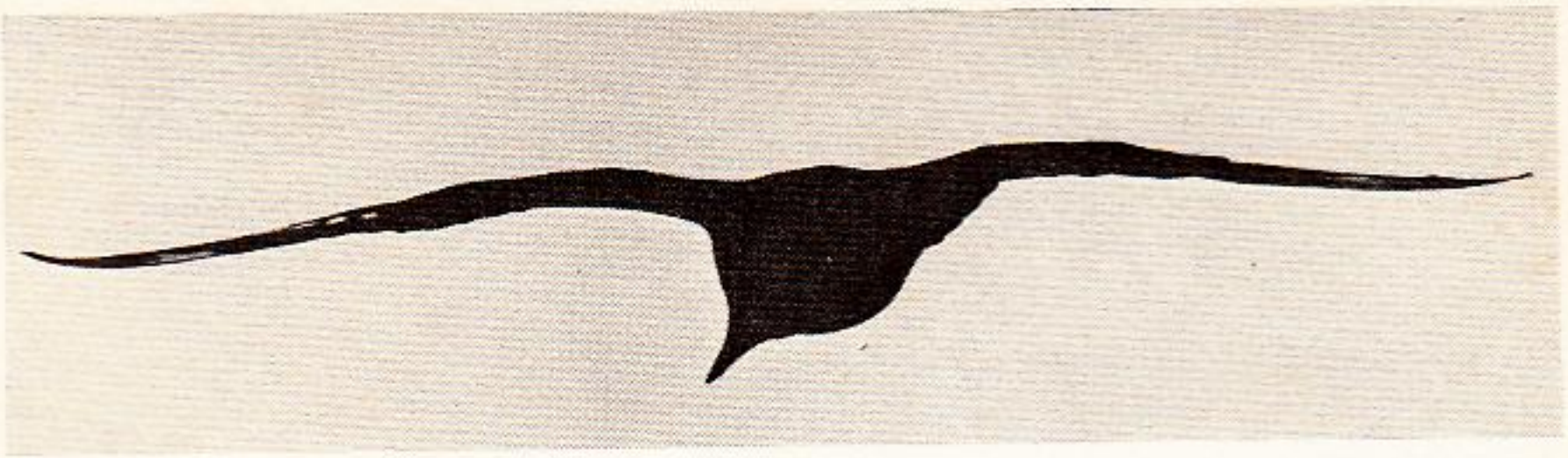
Here is one of them: the bigger the airplane or the faster it flies, the larger the landing strip it requires. For supersonic craft, the landing strip must be three and a half kilometres long. This is not to anyone's liking. No one is fond of wasting vast stretches of good land on airfields.

Just think of it: not so long ago, the mere fact of flying seemed a miracle, and today we are already haggling over the size of airfields!

Actually the airfield problem curtails the possibilities of aviation. How, for instance, can airplanes bring people and cargoes to mountainous regions? Of course, there are helicopters, but they have their own shortcomings. Whereas birds...

Ha, birds, the sceptic may laugh. Of course birds can fly away and land without any preparatory run. But all attempts to imitate the bird's flight have failed. True, so far all attempts to imitate birds have failed. This does not mean, however, that people have given up the idea altogether. This retreat was a temporary one which will end only when men fathom the secret of how a bird flies, of how its wings work. Today, birds are studied with the newest technical equipment and experimental apparatuses. Still their secret has not been unravelled. To this day, we do not know how birds withstand the tremendous strain of migration flights. Sometimes they must fly over sea or desert where they have no chance at all of resting or "re-fueling".

And take their manoeuvrability, for



The stormy petrel is a wizard flyer!

example. Can any flying apparatus whatever compare with the aerobatics performed by the swallow or the martlet at amazing speeds. And think of the humming bird which weighs a mere 5 grams but is nevertheless capable of flying forwards and backwards and hovering over a flower like a helicopter, making 50 wing-flaps a second!

Or take birds' lifting capacity. Birds can carry much greater loads (compared to their weight, of course) than the most powerful airplanes. And, finally, there is the matter of speed to consider.

All these accomplishment of birds — manoeuvrability, lifting power, speeds, take-off and landing — intrigue people no end, inducing them to do thousands of calculations, make endless observations of birds in cages and in flight, to study, compare, make models. Test models of "birdoplanes", or ornithopters, have already been constructed, but it is a long way from a model to a usable machine. Thousands of problems remain to be solved. Many of the birds' secrets must still be ferreted out before we can create a flying apparatus with flapping wings.

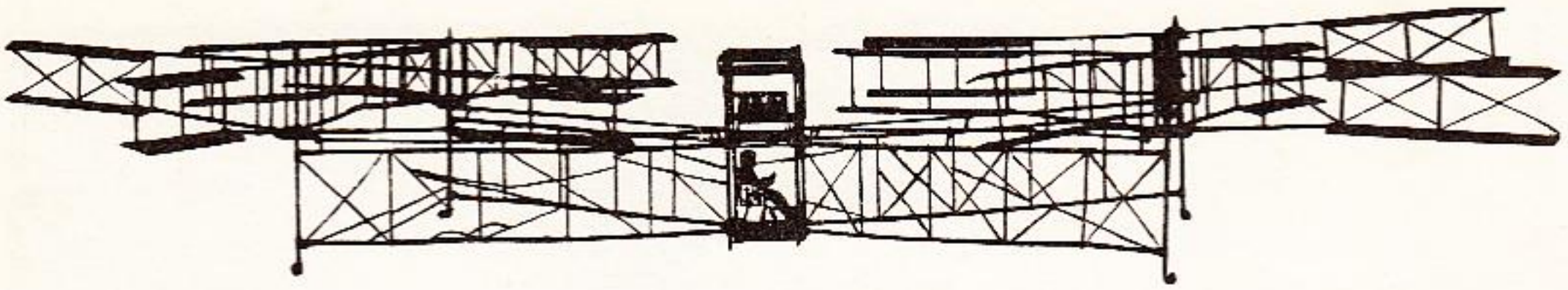
Meantime people only dream of such a contraption as they watch enviously the marvel of a bird's flight.

On the other hand, why only birds, entomologists may ask. There are many proficient flyers among the insects as well.

And so there are.

Let us begin with speeds. If we compare the average speed of a modern airliner (900 kilometres per hour) with that of a homing pigeon (60 kilometres per hour) we see that within a given time, the airplane will fly a distance equal to 1,500 body lengths, and the pigeon, 5,000 body lengths. But the awkward bumble-bee covers 10,000 body lengths. Mind you, I am speaking of relative and not absolute speeds. And if we take some dragonflies, which develop a speed of a hundred or more kilometres an hour, they cover a distance equal to 20 or 30 thousand body lengths in a minute. If an airplane could fly at comparable speeds, it could orbit the earth along the equator 20 to 30 times within an hour. So we see that in the matter of speed, insects are far superior to birds.

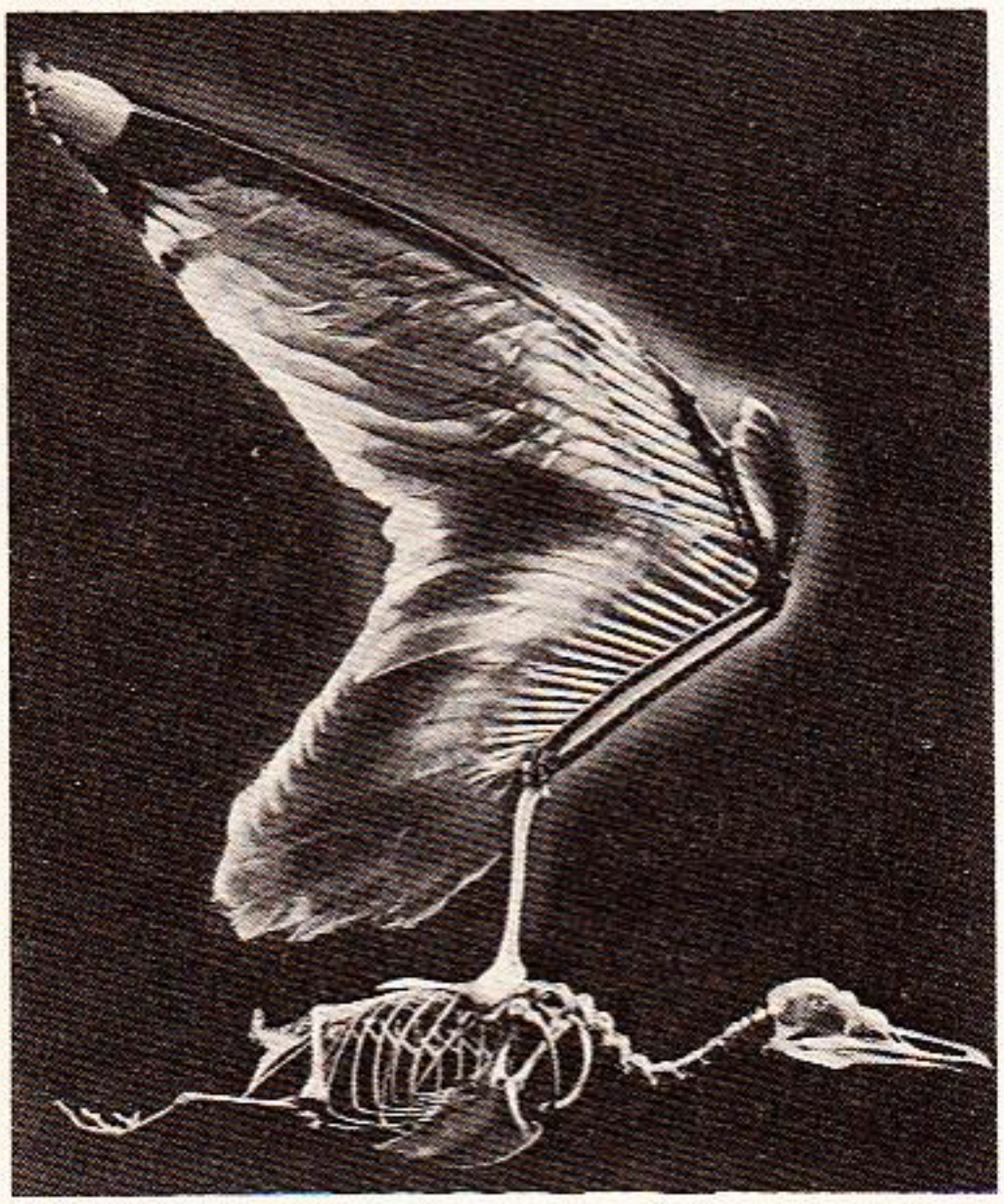
In range of flight, insects also hold their own. Recently, we have learnt that some butterflies make transcontinental flights while lady-birds and dragonflies can cover a thousand kilometres with ease. If we compare these



In 1907 man attempted to fly up in a glider of this design.

figures with birds' migrations, even in absolute figures, many insects can vie with birds, to say nothing of relative distances.

Scientists regard the bird's wing as a miracle of technical perfection. Indeed, what machine, what apparatus can compare with the wing of a small bird which makes nearly a million uninterrupted strokes in one migratory flight?



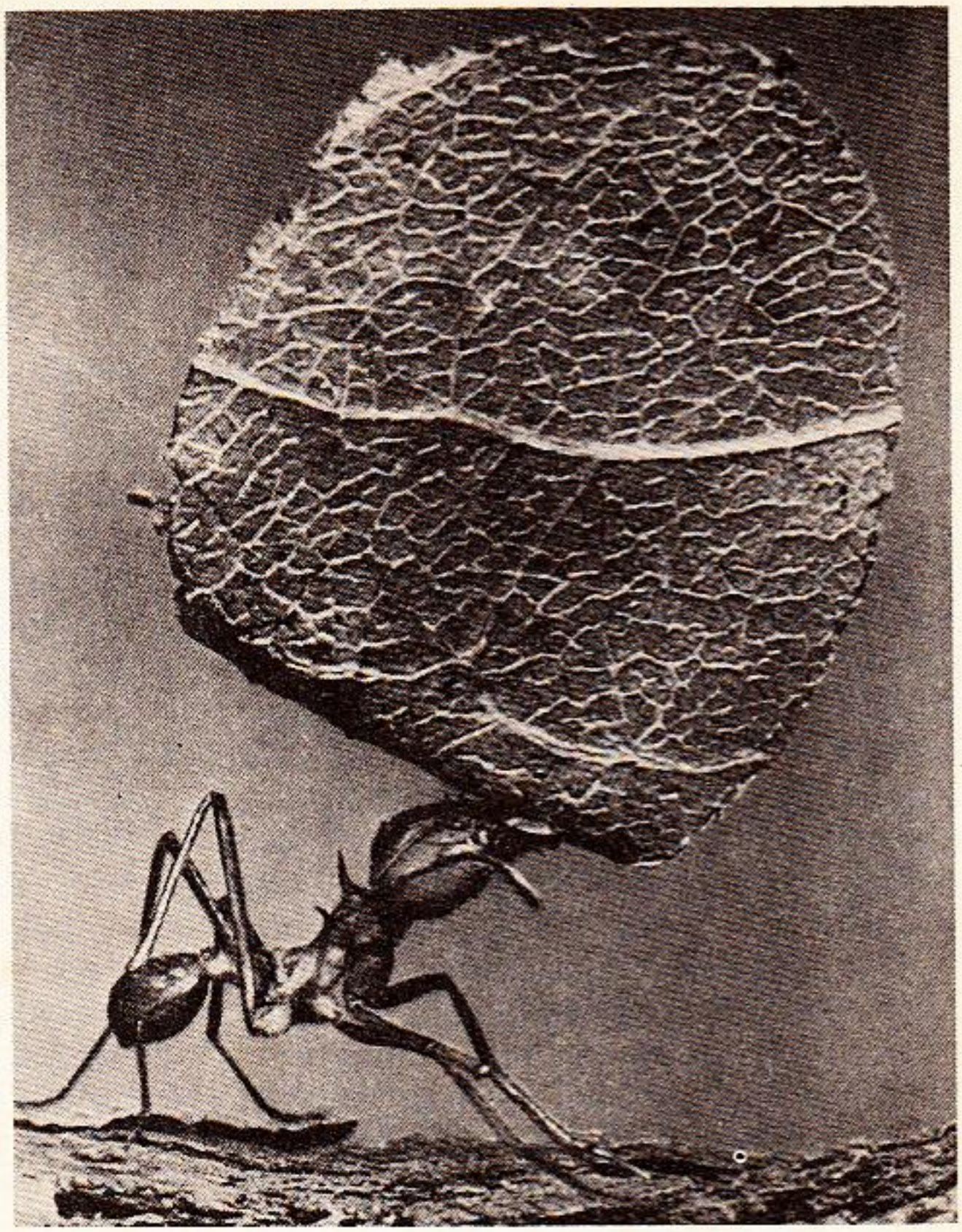
What then is the secret of the bird's wing?

But if a bird can fly for 40-50 hours flapping its wings all the time and taking no rest, insects are not capable of such a feat. Though hawk moths have been known to cover a distance of a thousand or more kilometres in a day and night, flying from the shores of the Black Sea to the Baltic or to Moscow, these are exceptional cases, as is the flight of dragonflies over a thousand and a half kilometres of sea or the flight of locusts across the Red Sea.

As a rule, migrating insects land from time to time for a rest. But even during a short flight their wings make many more strokes than birds. A bird makes, on the average, 4 to 6 strokes a second, which comes to 240-360 strokes a minute. But the bumble-bee makes 240 strokes a second, the housefly, 330-350, and mosquitoes, depending on the species, from 600 to 800, while certain species reach up to a thousand. Imagine the strength of a wing which can stand this kind of strain — 60,000 strokes a minute!

Now let us discuss manoeuvrability. Of course, among the third of a million kinds of flying insects there are some veritable aces.

Anyone who has had occasion to watch an *Aeschna cyanea* dragonfly has seen it perform amazing aerobatics. It will fly in a straight line, make a



Ants could teach people a lot of things.

sharp turn, dive, then rocket upwards. There is an unending succession of turns, dives and twists as the dragonfly pursues a fly, which is also executing all these figures. Incidentally, ordinary houseflies are among the most accomplished flyers as regards manoeuvrability, ability to hover in one position and speed of take-off. Just try to catch a fly crawling on the wall. This is a nearly impossible task, so fast does it take off from the wall, floor, or ceiling on which it was walking upside down. Needless to say, a fly needs no air strip to become airborne.

Some nocturnal butterflies stick their proboscis flawlessly into a flower and suck out the nectar while hovering in the air. Is this not an enviable accomplishment?

And finally there is the insects' lifting capacity. It has been established experimentally that insects can lift, relatively, much greater loads than birds, and, of course, incomparably more than the latest airplane.

So insects are worthy rivals of birds, and it is hard to say which will "father" some truly remarkable flying apparatus of the future. Perhaps both

will share the honour? Perhaps designers will borrow some ideas from birds and others from insects? Or perhaps, having delved into their secrets, they will design something entirely new, a flying apparatus that has no parallel in the animal world?

Be this as it may, the road to such a flying apparatus is sure to be long and arduous.

Animals do not like to divulge their secrets. Take the May bug, which has been studied extremely thoroughly, it would seem. We now know that before taking off, it pumps air into special sacks, that both it and its larva are dangerous pests which destroy leaves and roots of trees, and that ten May bug larvae are capable of destroying all the vegetation on a square metre of soil. We know when it begins to fly and when it lays its eggs, but the mechanics of its flight are still a mystery to man.

According to calculations, the May bug, to fly the way it does, ought to have had at least twice or thrice the lifting capacity it actually has — in other words, its "engine" ought to be two or three times more powerful. But this insect flies about oblivious to all our frustration and efforts to discover its secrets.

Again Birds or Insects

The fact that birds fly away to warm climes in autumn and return in spring no longer is questioned by anybody. Out of about a hundred thousand million birds living on the earth, approximately one fifth make these annual trips.

In the beginning, people did not believe in the existence of migratory flights and, when they established this fact beyond all doubt, they decided to find out where northern birds spent the winter.

No one could devise a method of ascertaining it until in 1899, the Danish schoolteacher Martens suggested the ringing of birds — putting a ring of light metal on a bird's leg. One cannot stamp much on such a ring, but much is not needed — just the name of the city where the ring has to be sent, and the serial number. By this number, ornithologists are able to establish where and when the bird has been ringed.

In the seventy odd years which have passed since the Danish schoolteacher put the first ring on a bird's leg, more than 10 million birds have been ringed. In this way, people have found out where birds winter, along which routes they fly, how long the trip takes, and at what altitudes and speeds they travel. But the more people found out, the more puzzles appeared.

Birds' staying power, economy of effort, and wing strength all presented problems which are still being grappled with by ornithologists. But the question which offers the greatest challenge to ornithologists, and not only to them, is how birds find their way.

It has been known for centuries that birds easily determine the proper direction and unerringly arrive at the right location; people used swallows and homing pigeons to send messages 5 thousand years ago. Ancient Egyptians, Romans and Greeks, when they went away, took along birds caught in nests near their houses. They agreed with their families and friends beforehand about various signals (for instance, a red ribbon would signify success and a blue one, failure), then tied the ribbon to the bird's leg and set it free to carry home the news of victory or defeat.

With time, instead of agreed signals, people began to tie to the birds' legs capsules containing notes. As the postal service developed, pigeon mail practically ceased to exist ... but only for a while. During the Second World War, for instance, the British Army had on its muster-roll more than 200 thousand homing pigeons. Some telegraph agencies abroad still use homing pigeons for short communications, believing this to be the cheapest, fastest and most reliable method.

For a long time, it was believed that pigeons find the way home from memory — they simply remember the route. But to remember, they must at the very least have seen it. As a rule, pigeons were carried in covered baskets or boxes, yet they returned home from wherever they happened to have been taken.

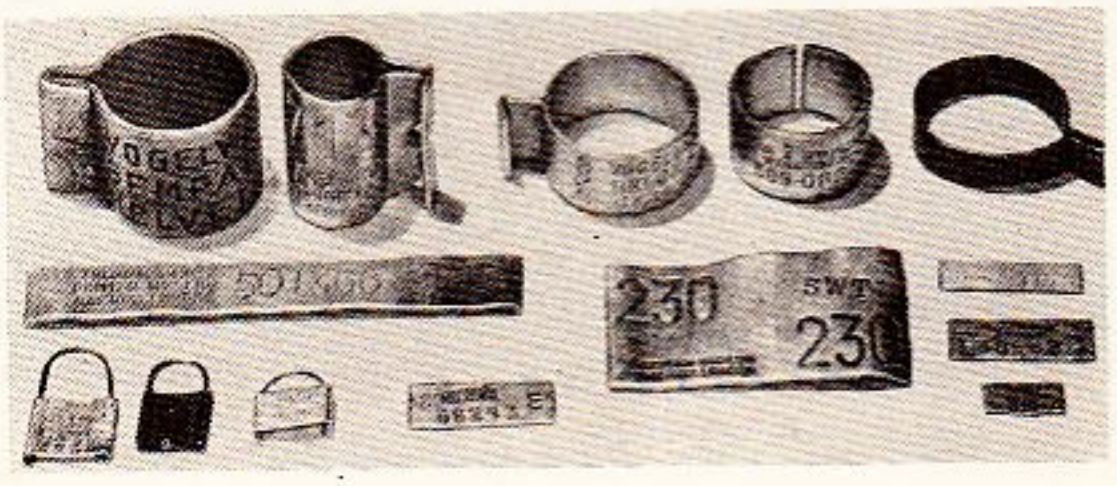
One of the theories attempting to explain the pigeons' powers of orientation suggested that the birds remembered mechanically all the turns and deviations from the point of departure. To test this hypothesis, birds were carried in boxes put on rotating gramophone discs and even given tranquilizers, yet they returned home unless some disaster overtook them on the way. So it is not a question of memory, for no memory can help a bird which has been drugged.

Ornithologists use the term "homing" a great deal, and indeed the instinct of home is very strong in birds — not just in pigeons. Lots of other birds return to their nests after being taken away. But then birds do not only fly home; they also leave it in autumn when they start their migration flights.

After the theory of memory was disproved, a new one appeared. This suggested that birds fly to their wintering places and back not along a straight line but in a spiral — in circles as it were. These circles gradually expand until the birds see familiar signs which help them get on the proper course.

The champions of the spiral theory were able to present some evidence in support of it. Birds do have excellent eyesight. It has been established that from an altitude of 200 metres, a bird can see for a radius of 50 kilometres, and from 2,000 metres, its radius of vision expands to 160 kilometres. Another argument advanced by the supporters of the spiral theory was the duration of the birds' flight. Some birds spend several months migrating, although the martlet, which covers a distance of 1,000-1,200 kilometres a day, could make the entire journey in a week. The supporters of the spiral theory saw this as proof that birds do not fly straight but in circles.

However, this theory, too, was disproved. It was established that the long duration of migration flights was accounted for by very different reasons: during flight birds make long stops to



Thousands of such tiny rings are put on birds' legs every year to study their migration flights.

rest, feed and wait out stormy weather. It was proved that while flying over the ocean, birds cannot see any landmarks. And, finally, a bird can recognise such landmarks only during a repeated flight, while young birds are making the journey for the first time in their lives.

The spiral theory was replaced by one according to which young birds are guided by old ones. This theory persisted a long time, and it was quite difficult to disprove. Especially since in many species, old birds really do fly together with the young. But now ornithologists have established beyond all doubt that young birds do not need the guidance of old ones. Were it not so, young starlings would not fly away before older ones, while the cuckoos, which do not know their true parents, would not be able to fly south at all. But they do fly away — each bird on its own. Moreover, young cuckoos, like many other species of birds, winter in different localities than old ones. Ornithologists have staged hundreds of experiments and carried out thousands of observations to be able to assert that old birds do not show young ones the way.

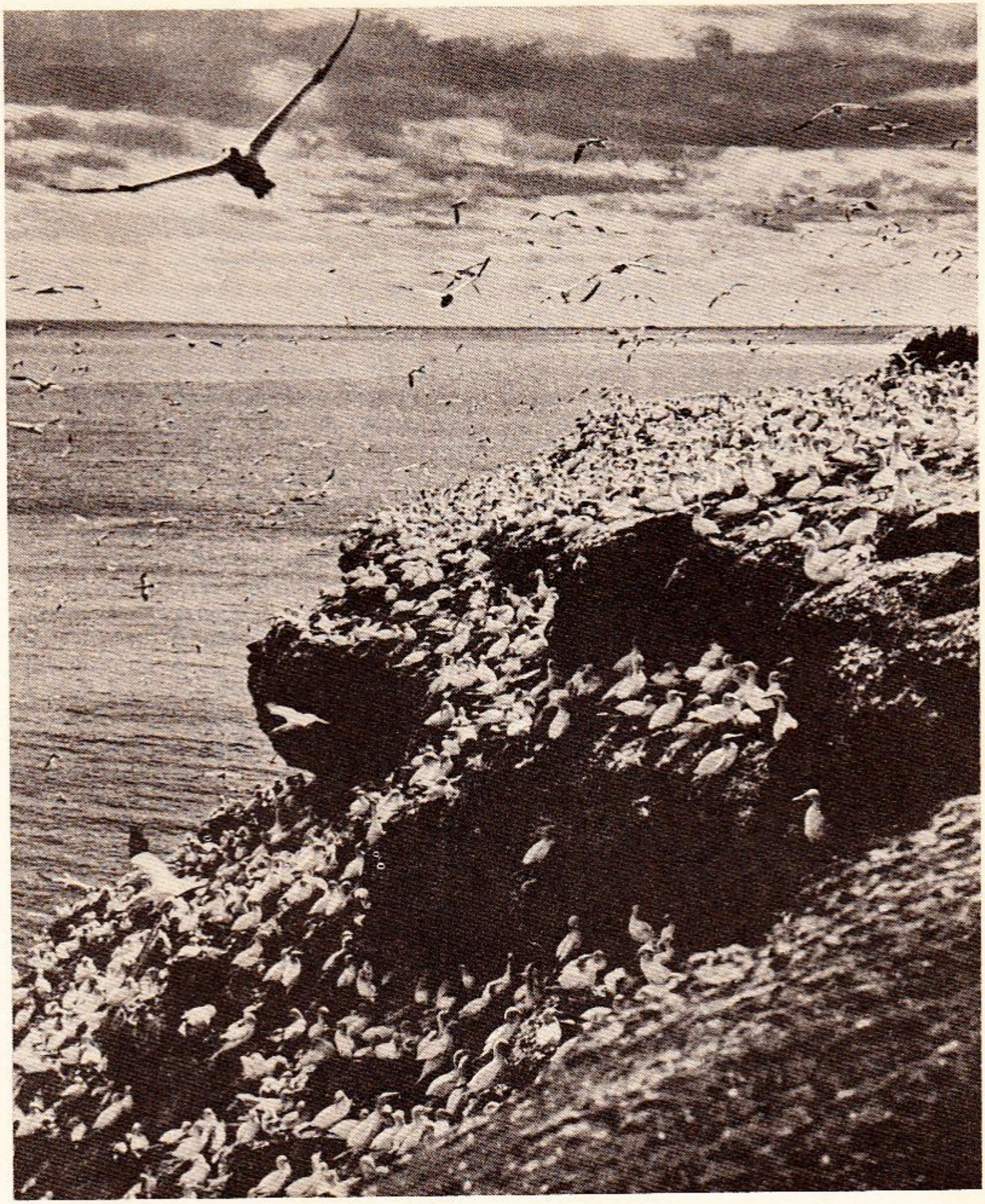
In the mid-19th century, the Russian scholar Academician A. F. Middendorf suggested the theory of magnetic orientation of birds according to which birds are sensitive not only to the general direction of the magnetic pole but also to magnetic deviations. To check this assertion, many more experiments were staged: magnets were put on birds, a magnetic field was created around them to put them off the right direction; they were taken to points on the globe where the forces of the earth's rotation were expected to interfere with their orientation if it indeed depended on indicators of the magnetic field. But the birds disproved this theory, too. True, the magnetic theory still has a few supporters, but many more have since been proposed. There is one suggesting thermal orientation, wherein slight wafts of warm air emanating from the south guide them. But this theory, too, has failed to find confirmation.

One theory after another was disproved. The method of disproving some idea was always the same — the "carting away" of birds. The idea is to catch a bird in its nest or during a migration flight and cart it off somewhere, then ring and release it to see where it will go.

For a long time, this was the only method of checking the migration's duration and correctness of the bird's orientation. This method proved the untenability of many theories, but it was insufficient, in and of itself, to supply an answer to the puzzle. Meanwhile science marched ahead and new devices offering new opportunities appeared. These were used by the German ornithologist Gustav Kramer, who instituted a series of experiments using the "circular cage". He obtained really remarkable results.

People noticed long ago that with the approach of spring or autumn, birds which are kept in cages become restless, too, flapping their wings and trying to fly in their cages. Moreover, these flights are different from their normal flitting about, for they are performed in a very definite direction. Even when a bird is sitting on its perch its head is turned in the same direction. These observations prompted an experiment.

A starling was placed in a circular cage covered on all sides. The cage itself was put in a round pavilion also having no windows. But in the ceiling,



With the help of these rings men find out where the birds fly, where they build their nests.

eight portholes were made through which the starling could see the sky. When the sky was overcast, the starling flew about the cage haphazardly and sat on various perches. But as soon as the sun peeped into one of the portholes, the bird's movements became oriented toward the sun.

To check whether it was really the sun which provided guidance to the starling, the experimenters used mirrors to change the direction of its rays. The starling, unaware of the deception, followed the indications of the luminary.

That, of course, was a major discovery which caused a revolution in our concepts of birds' behaviour. Kramer and other ornithologists after him, carried out hundreds of experiments with different birds, changing the sun's "speed" with the help of various contraptions and even "stopping" it altogether to mislead the birds. And each experiment provided yet another proof that birds were indeed guided by the sun.

When this was proved beyond all doubt, however, another complex problem arose. After all, the sun is constantly in motion. How are birds able to follow the right route nonetheless?

Then even more amazing "abilities" were discovered in birds. A man who knows that the sun rises in the east in the morning, is in the south at midday and the west in the evening, is able to orient himself. And if he has a wrist watch, he can establish direction with a fair degree of precision. But birds have no watches to enable them to make the proper adjustments and determine direction at any moment of the day!

But as it turns out, birds do have one. It is called the biological, or physiological, clock and not only birds, but insects, plants and man also have such "internal clocks".

We are used to the idea that a clock is a device, an object, in short, a *thing*. However, the biological clock is not a thing but a phenomenon. Nobody knows where it is situated, and it cannot be seen. But living organisms are constantly aware of its presence and, in fact, cannot do without it. Here are two very simple examples. First of all, jet lag. A person flies from Moscow to Irkutsk in Siberia. The difference in time is 5 hours. In Moscow he is used to going to bed at midnight and getting up at seven in the morning. But in Irkutsk, midnight comes when it is still seven p. m. in Moscow. So the poor Muscovite tosses and turns in his bed, unable to go to sleep. He has moved his wrist watch five hours ahead, but his biological clock is still on Moscow time. The same thing will happen in the morning. A Muscovite will find it very difficult to get up at 7 o'clock in the morning. The opposite will happen to a resident of Irkutsk in Moscow: at 7 in the evening, he will feel sleepy, and will wake up at 2 in the morning. Several days will pass before the biological clock gets adjusted to the local time.

Another example. In early spring, people often break off a few twigs from a tree and put them in water. Although it is still cold outside, buds will swell and burst, and young leaves will sprout. But if you try doing this in winter, no matter how warm the room is, nothing will happen. The plant's "clock" is set for a definite season and gives the command to wake up in spring and to fall asleep in autumn.

This biological clock governs the lives of animals, waking them in the morning, if they are active in the

daytime and in the evening if they are nocturnal; the biological clock "makes" animals hibernate in winter, tells migratory birds when it is time to fly south, and indicates when burrows must be dug, nests built, etc. No one knows how many such clocks an organism contains, nor do we know whether the same clocks or different ones govern various actions of animals. But the existence of such a phenomenon is indisputable. And the fact that this clock helps birds orient themselves using the position of the sun has also been established.

So the sun is the reference point birds use to find the direction, and the biological clock is the instrument which helps them make the necessary corrections according to the sun's movement and keep on course. But this is not all, for birds fly not only in a definite direction but to a very specific locality. And to find this place, determining the correct point of the compass is not enough. Many birds are capable of locating with precision a tiny island lost in the ocean, while others, having covered many thousand of kilometres, find not only their native land but the exact place where they were born, and build their own nests near their old "homes". What enables the birds to fly with such a great degree of accuracy? What is the amazing "device" that keeps them from straying off course, despite the winds, the air currents and many other factors which are impossible to foresee and which hinder their flight?

And then, there are quite a few species of birds which fly at night. How do they find their way?

Some ornithologists believe they use the stars as guides. Some robins and warblers were released in a planetarium, and they set their course by the stars in it. If the arrangement on the star map was changed, the birds at once changed the course of their flight. Yes, obviously stars do help birds orient themselves.

Other experiments have shown, however, that even birds flying at night orient themselves by the sun. They fix in their minds the position of the setting sun, as it were, and thus choose the proper direction.

But while theories were elaborated and experiments being conducted with birds, spectacular new discoveries rocked the zoological world — discoveries of transcontinental flights of insects, particularly butterflies.

The fact that some butterflies fly *en masse* has been known as long as people have known of birds' fantastic journeys. Old manuscripts and books tell us about occasions when butterflies "blocked out" the sun above European cities, and sailors often saw great swarms of butterflies hundreds of kilometres from the shore. However, nobody could explain the significance of these swarms high above cities or over the open sea. In the 50s of this century it was established that butterflies make flights across seas, from one continent to another. We learned about the butterfly *Nomophila noctuella* which flies from England to North Africa and back; we learned about the monarch butterfly which lives in Canada but winters in Florida or even New Zealand, covering almost 4,000 kilometres each time. Even among our own Russian butterflies, there are zealous "travellers" — the admiral, the white cabbage butterfly, and the thistle butterfly, for example. The white cabbage butterfly and thistle butterfly fly in swarms, while the admiral prefers to travel alone. We now know at what height butterflies travel — usual-

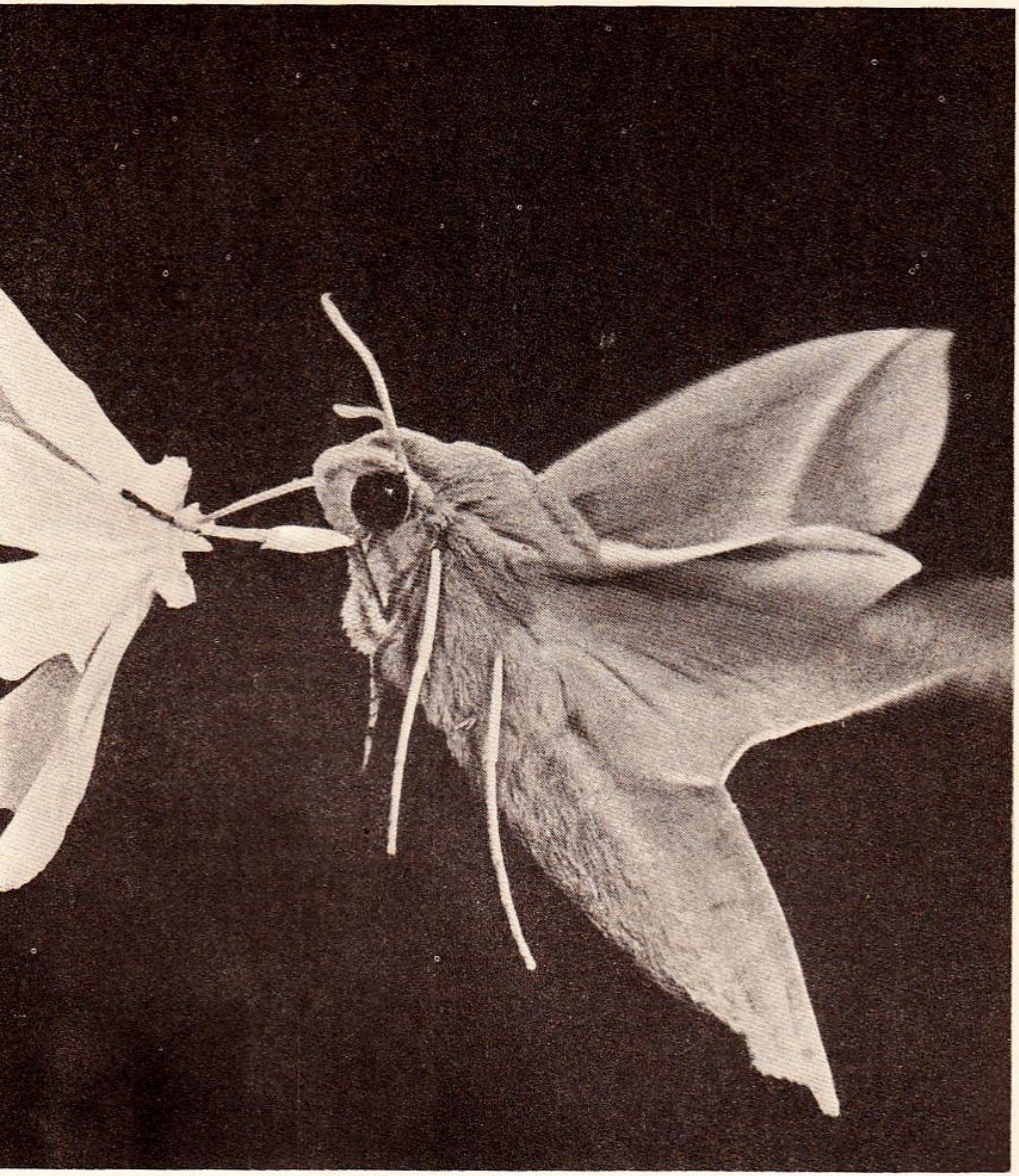
ly two or three metres above the ground — and the speed of their flight. The white cabbage butterfly, for instance, flies at a speed of 7-14 kilometres an hour if there is no wind, and if the wind is propitious, it can reach velocities of as much as 30-35 kilometres.

We know many other details about butterflies' flights, but the fundamental problems have not yet been solved.

One of these is the wind. Birds do not mind the wind unless it is very strong; in such cases, they simply wait it out. Butterflies, on the other hand, should be sensitive, it would seem, to the slightest puff of wind, which might carry them off course. Yet the wind does not seem to bother them, and they are not blown off their route. This means they must have some mechanism unknown to people which directs their flight. It has been observed that the stronger the wind, the larger the angle between it and the butterflies' bodies. But how do they measure the strength of the wind? How do butterflies discover that there is a wind blowing in general? It is easy enough for us to determine, standing as we do on firm ground. But in the air, it is quite difficult to tell how strong the wind is. Yet butterflies not only do that but also use favourable air currents.

The very fact of butterflies' flights over enormous distances is a great puzzle. Their wings seem so weak it is hard to imagine how they are capable of carrying their "owners" from one continent to another.

And, finally, the crucial question — how do butterflies find the way? There can be no question of memory or of old butterflies showing the road to young ones — some butterflies fly in enormous swarms, others by themselves; some fly



Even the modern helicopter is no match for the hawk moth.

there and back, others only one way. Once they arrive, they lay their eggs and die, while the newly hatched butterflies make their way back independently. Obviously there are special "apparatuses" or "mechanisms" at work, but we do not know what they are.

Not only butterflies, but also dragonflies, lady-birds and some beetles make long journeys. How do they orient themselves? And once again, in the study of insects, people have come up with a magnetic theory. While it is believed that most birds do not possess a "magnetic sense", experiments have shown that insects are endowed with such a sense. A fly, for instance, when landing on a horizontal surface, always orients itself in a north-south or east-west direction. Some other insects have been observed to do so as well.

Thus, the magnetic field theory cannot be discarded out of hand, at least for insects. True, we do not have any data about "magnetic sense" in butterflies, but after all, there are still many gaps in our knowledge of insects.

And these gaps must be filled. We cannot even imagine what amazing secrets are still to be discovered about birds and insects. The study of their migrations alone has yielded a wealth of useful information. For instance, zoologists are of the opinion that protection of useful birds could be more efficiently organised if we knew the routes of birds' migration flights and their resting sites.

It is not only ornithologists, however, who are interested in migration flights of birds and insects, but also engineers and designers. And no wonder: after all, both birds and insects seem to have remarkable, very perfect compasses — high precision devices which lead them unerringly to their destination, making the needed corrections and laying the course without anybody's help.

How useful such an instrument would be for human navigators! And not just this one!

Echolocators

Although the secrets of bats were unravelled not so long ago, the first experiments having been launched in 1938, a lot has been written about these animals since. Various creepy tales were once told about bats; legends were invented about their bloodthirstiness. It was even averred they were the servants of the Devil. But whatever extraordinary properties were imputed to them by superstitious people, the reality proved to be much more extraordinary.

People have always disliked bats because of their eerie appearance and mysterious nocturnal habits. They thawed out to bats a little after finding out that these small animals destroy enormous quantities of harmful insects, including malaria mosquitoes. Still, bats were not fully exonerated. Their enemies offered weighty proofs that bats were involved in some devilry. Even the fact that they caught harmful insects spoke against them, for *how* did they catch them? In flight and, as often as not, in utter darkness. Surely this could not be done without the aid of the Devil himself!

Champions of bats could not explain this fact, no matter how hard they tried. And try they did. Back in 1794, the Italian Lazzaro Spallanzani tried to discover how this animal managed to fly and see in the dark. He proved that even a blinded bat was perfectly capable of finding its way in the dark, while one that was deprived of its hearing

Antennae like these are the most sensitive "nose" in the world.

became completely helpless at once. As soon as the plugs were removed from its ears, it was again able to fly normally without hitting objects. Spallanzani came to the conclusion that bats "see" with their ears, but he was not able to offer any further explanations, for before the bats' secret was discovered, many sciences, especially physics, had to develop considerably.

Almost 150 years later, scientists repeated Spallanzani's experiments. But this time they were armed with instruments capable of perceiving sounds that are beyond the range of human hearing. It was discovered that bats emit high frequency sounds.

Sound is a vibration of the air. The strings of a guitar, if you strum them, will start vibrating and will make the surrounding air vibrate as well. Under normal conditions, air vibrations spread at a speed of 300 metres a second and, when they reach a man's eardrums, make it vibrate as well. Our nerves carry these signals to the brain, and thus we hear the sound. But not all sounds. There are different sound frequences, and the human ear perceives sound vibrations within a range of 16 to 20 thousand cycles per second. Extremely high- or low-frequency sounds are not perceived by the human ear, but they certainly exist. These that lie

below the level of our perception are called low frequency sounds, and those above, high-frequency sounds.

Bats emit high-frequency sounds of up to 150 thousand cycles per second or a bit lower, but still beyond the range of human perception. These sounds are reflected off objects and this helps bats to orient themselves.

We all know what an echo is. If you shout, even softly, in an empty room, after hitting the walls of the room, the sound will come back to you, although a bit distorted.

The distortion depends on a number of factors, first of all the distance involved and the composition of the obstacle the sound hits.

It is on this principle that echo orientation, or, as it is also called, echolocation of bats is based.

This is how it occurs in principle: the bat sends out high-frequency sounds. The sound waves spread freely until they come up against an obstacle. After that they are reflected back, and the animal, whose ears are perceptive to high-frequency sounds, hears them and, judging by the time that was needed for the return of the sound, it establishes the location of the obstacle.

It seems easy enough. But when people delved a bit deeper into the matter, they came to appreciate the excellence of the bat's echolocator more fully.

To begin with, just imagine what a perfect measuring instrument the bat has if, with lightning speed, it can measure the distance from itself to the obstacle on the basis of the speed of the reflected sound. It also has another "automatic device" that guides its flight toward the obstacle. And automatic it is, because the brain cannot possibly receive the signal and command a braking or turning manoeuvre in this tiny fraction of a second.

Furthermore, in a single second, the bat emits from 10 to 20 series of high-frequency scouting sounds. If it becomes "interested" in something, it emits up to 250 cycles and receives as many, reacting to them instantaneously. You can judge of the quality of this reaction watching a bat at hunt: all its turns, dives and soarings are guided by the sounds emitted and received.

To establish the speed of the bat's reaction and the precision and nimbleness of its manoeuvres in the air, many experiments were staged. One of them revealed that given an abundance of insects, a bat can catch an average of 160-170 mosquitoes in an hour.

Moreover, bats determine not only the distance to the object and its size, but whether it is edible or not. In experiments, objects resembling mealworms in shape were tossed into the air. But while the bats caught and swallowed real mealworms, they paid no attention to inedible objects resembling them.

This does not mean, however, that bats "feel out" only edible objects. If that were the case, they would be constantly flying into tree trunks, house roofs, etc. Sounds and their reflections not only help bats to hunt but also to find their way in space. Experiments have shown that a bat feels and avoids a wire the thickness of a human hair stretched in its way.

If only man had such a marvellous apparatus! How many blind persons would become almost sighted! True, something has already been done along these lines: a model of an echolocator for blind people based on that of bats has already been developed. But it is very crude as yet, and blind people still rely more on the walking stick. Let us hope

that bats will suggest how to improve this apparatus. And not only bats either — there are other animals equipped with echo sounding devices. One is the nightjar who lives in South America, and another, the martlet famous for its tasty nest favoured by gourmets.

Some fish, whales and dolphins have sonar locators as well. The latter are a real treasure trove for study and imitation. Just think of the unique devices they possess — skin, sonar locators and many other things that can be very useful to man. It is for this reason that hunting dolphins is strictly forbidden in most countries of the world.

"Chemists" and Others

Not only are engineers and designers interested in animals as nature's living models. The ordinary housefly, so hateful to doctors and so admired by aircraft designers, is also of interest to chemists.

To be sure, chemists are constantly inventing all kinds of preparations to kill flies, those nasty carriers of bacteria, but at the same time, they would not mind learning a thing or two from the fly. The tiny hairs on a fly's legs are a really amazing chemical laboratory. To determine the chemical composition of an object, the fly needn't perform any complex analyses, for it receives all the information it needs just by touching the object with its leg.

Spiders, too, interest other specialists than designers. In fact, textile industry specialists first became interested in spiders more than two hundred years ago, when people first tried to put spider's web to good use. They even wove it and made stockings and gloves for French King Louis XIV. Gloves of the same kind were presented to the wife of Holy Roman Emperor Carl VI. Early in this century, a special spider farm was set up in France to produce spider silk (after all, if there are silk-worm farms, why not spider farms?). But the farm soon went out of business because it proved impossible to keep those voracious creatures fed: to do that another dozen fly farms would have had to be set up nearby just to feed the spiders. So, it looks as though spiders cannot be bred artificially. Of course, finding some way to obtain their webs for fabrics was a very tempting proposition, for they are stronger than steel and so light that a thread long enough to circle the globe would weigh only 350 grams.

The farm idea fell through, but maybe chemists can help. If they can find out how the web is made, perhaps they can produce artificial spider's web?

Another insect that interests chemists is the bombardier beetle. When in danger, it bends its front legs, lifts its tail end and shoots out a spurt of liquid which immediately turns into a cloud of gas. After studying the beetle's anatomy, entomologists established that the beetle has two special "chambers" where special substances are produced and stored. When the beetle is frightened, these substances are quickly sent to a third chamber where they are intermixed and due to the resultant chemical reaction, oxygen is isolated. Oxygen pushes the liquid out with great force, and in the air, it turns into a gas. This is a very curious process in and of itself. Moreover, at the moment of the "discharge", the temperature of the beetle's body reaches a hundred degrees centigrade. And the beetle, far from being cooked, does not even get a burn.

One problem chemists have been grappling with for years is that of

An insect's eye consists of a thousand tiny eyes. And each has very keen vision.

preserving hydrogen peroxide, a substance which disintegrates very quickly. One of the bombardier beetle's chambers stores hydrogen peroxide, and there, it does not disintegrate at all. Chemists are of the opinion that the beetle's body secretes a substance that prevents its disintegration. What is this substance and how does the beetle produce it? This is a problem yet to be solved.

Another point of interest to chemists (and, of course, to designers as well) is the sense of smell in insects. When we speak of sensitive noses, we usually mention the dog. It never occurs to anyone to say that somebody has a nose as keen as a butterfly or a housefly. But the fact is that the sense of smell of insects is dozens and even hundreds of times keener than that of other animals. For instance, males of certain butterflies become aware of the appearance of females several kilometres away. How chemists would love to discover the design of such an apparatus and build a similar one. (Incidentally, fish have sense of smell almost as keen as insects, for they become aware of a few kilograms of dye dissolved in the whole of the Sea of Aral.) Chemists are also fascinated by many other insects, fishes and animals, including birds, especially those birds which possess a "desalinating" apparatus. Of course, they cannot get far without the help of biologists and designers, but this help will be provided very willingly: after all, the problem of fresh water on the globe is a very urgent one, since its reserves are being depleted constantly, while the need for it is growing just as fast. Man has long been wondering how to desalinate the water of seas and oceans, and several models of desalinating installations have even been developed. But in nature, such

With many insects the wings serve for purposes of signalling as well as flying.

devices have existed since time immemorial.

Sea birds are often unable to obtain fresh water, living as they do in the open sea and coming ashore only during the nesting season. It was believed for a long time that these birds had no need of water and obtained the necessary liquid from food, until it was established that many sea birds drink briny sea water. Yet their organisms receive excellent fresh water, purified of all salts and admixtures. The sea water they drink passes through special glands (a cluster of tubes situated on the beak near the eyes) in which salt is separated and ejected, while fresh water remains in the organism.

Other animals besides birds also possess "desalinators". For a long time there was a legend about the crocodile's soft-heartedness or, perhaps, hypocrisy. Eyewitnesses asserted that tears often roll from a crocodile's eyes while it is eating its prey (hence the expression "crocodile tears"). In the end, zoologists proved that the crocodile is neither soft-hearted nor hypocritical, and moreover, that it cannot weep and has no tear glands at all. What it does have is a desalinating mechanism. The crocodile's kidneys often fail to deal with the excess of salts which enter its body with the food it eats, so they are assisted by special glands situated near the eyes through which salts dissolved in water are ejected.

Many more animals, from tiny flies to huge whales, attract the interest of scientists and engineers.

I could tell about many existing apparatuses the ideas for which were suggested by animals. But even when man learns some of the animals' secrets, he is often unable to make full use of them.

Here are three examples. The study of the bat's locatory device has suggested a model of an apparatus to help blind people find their way about. But this apparatus developed so far is not practical, for it is too big and heavy, while the bat weighs a mere 7 or 8 grams.

For a long time people had no idea as to the purpose the hollows on the heads of some American and Asian snakes served. They simply looked like an additional pair of nostrils. The mystery was solved only when the following experiment was staged. A snake was deprived of all senses known to us, and an electric bulb was brought close to its head. As long as the lamp was turned off, the snake did not react to it. But as soon as electric current was switched on and the lamp began to get warm, the snake attacked it. And although the snake was unable to see the lamp, its aim was very accurate.

It then became clear that the hollows on the snake's head are openings for a very sensitive thermal locator. Thanks to this, the snake although it has poor eyesight and hearing and hunts at night, finds its prey easily (for all living creatures emanate warmth) and is able to catch it expertly.

Men not only unravelled the snake's secret but also built a thermal locator along the same lines. And while the snake's device registers a difference in temperature of one thousandth of a degree, the apparatus designed by man can register a difference of five ten-thousandths of a degree. Yet the snake's locator is more perfect. Of course, it has only half the sensitivity, but on the other hand, it is dozens of times smaller in size.

And, finally, one more example. Having probed the dolphin's secret and developed an artificial dolphin skin, man has still not been able to achieve the speed dolphins are able to reach in a relatively short time.

Naturally these and other apparatuses will be further perfected, their sensitivity will be increased, and at the same time, their size will be reduced. Without this, strange as it may seem, technological progress is impossible.

Animals will surely come to Man's aid — both ordinary domestic animals which are always about and the rare ones man will save for the delight of future generations and for science.

Yuri Dmitriev was born on December 14, 1925, into the family of a physician. He belongs to the generation whose adolescence coincided with the war. Like other teenagers, he did guard duty on the roof of his house, watching out for incendiary bombs and tried to gain admittance to the acting army, though he was not yet of age.

When the war ended, Dmitriev got a job on a newspaper and simultaneously attended Moscow University. Upon graduation, he began teaching at school. He was a fine teacher, well liked by his pupils and respected by his colleagues. He wrote an excellent master's thesis so his future seemed to be clear-cut. Yes, he loved his work, but more than anything else he loved animals. In childhood he kept gold-fish and dogs, and there were always various small animals and birds, living in his home—and not confined to cages either. As a rule, Yuri picked them up in the street, ill, wounded, half-frozen, starved, and nursed them back to health, after which they could return to freedom if they chose.

So Dmitriev started writing about animals. His first story, which was published in the newspaper *Moskovsky Komsomolets* and was entitled *The Green Patrol*, was about nature and animals, and already in this first book Dmitriev did his best to infect boys and girls with his own love for nature and his dedication to its protection.

In the two books by Yuri Dmitriev Raduga Publishers are bringing out, *Man and Animals* and *Animals on a Pedestal*, the young reader is offered much interesting information about wild and domestic animals, and is urged to be kind to them because man is responsible for every living thing on Earth.